POWER

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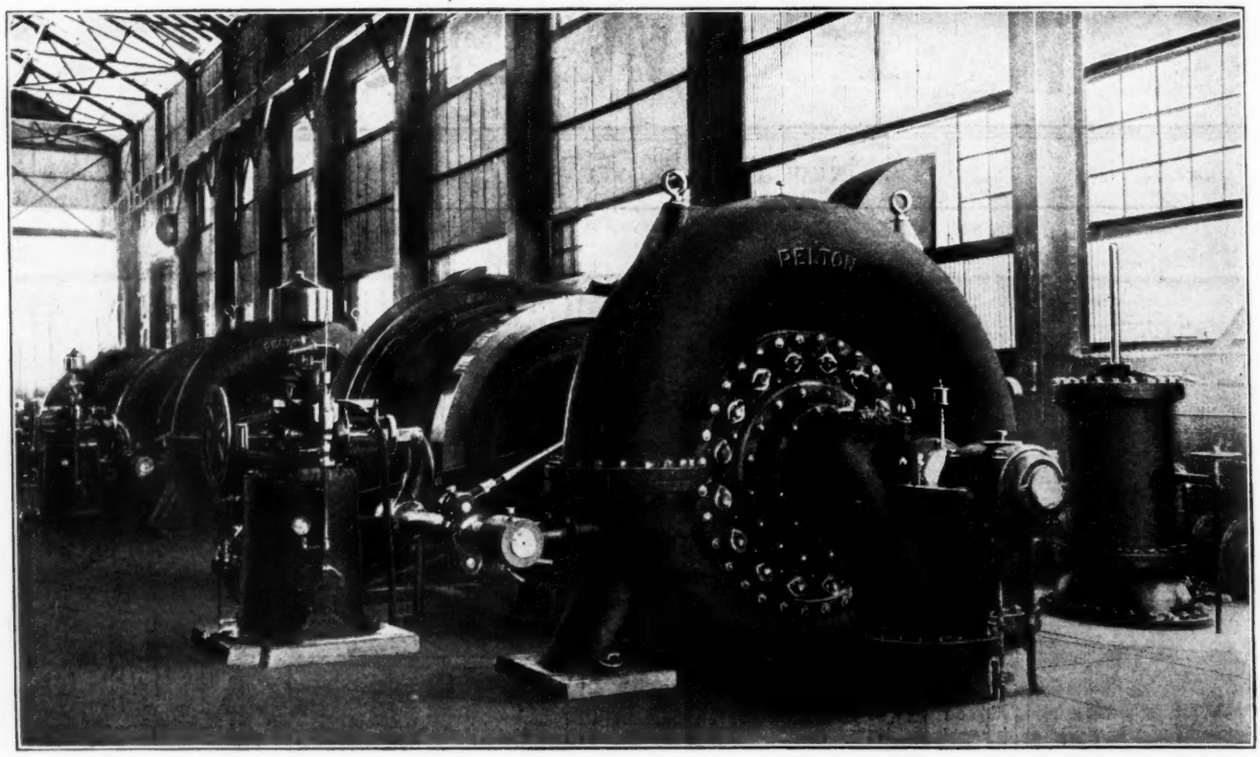
Get While the Getting is Good



Braden Copper Company's Power System in Chile

Two Hydro-Electric Plants Supply Power to Copper Mines—One 22,500-Kw. Plant Operates Under 1,550-Ft. Head—The Other Plant, 15,000 Kw., Operates Under 440-Ft. Head—Large Amount of Silt in Water Causes Serious Operating Problems—Substation Cut Out of Solid Rock 4,000 Ft. Under Ground

SITUATED on the eastern slope of the Andes Mountains, at an altitude of about 7,000 ft., is the Braden Copper Company's copper-mining plant in Chile. It lies within the province of O'Higgins about 65 miles from the City of Santiago and about 125 miles from Valparaiso, which is the principal accessible seaport. Access to the property is by means of the company's own railroad to Rancagua, 43.5 miles in length, which connects the main plant at Sewell with the railroad leading to Santiago and Valparaiso. The situation of the property with reference to power supply is fortunate, since near-by streams afford ample opportunity for hydro-electric development.

In this section of Chile the run-off of rivers is naturally poorly regulated since the watersheds are practically barren. During the summer season, when the principal source of water is from glaciers and melting snow and, in some cases, springs having a relatively constant discharge, the flow is more nearly constant. On account of the barren character of watersheds large quantities of refuse and glacial silt are present during high-water periods. The solid matter carried by these streams during high water seriously interferes with the operation of intakes, gates, sand traps, etc.

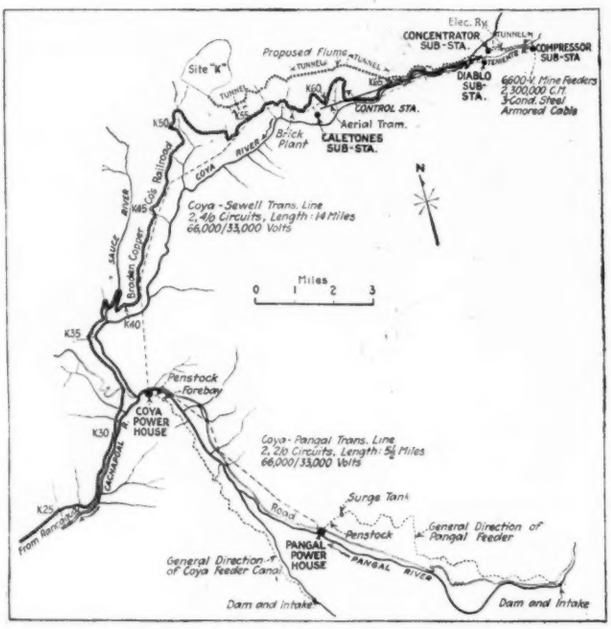


FIG. 1. LOCATION OF POWER HOUSES AND MINES

Of very serious consideration is the intake problem. To secure the best results it is absolutely essential to resort to designs whereby the flow into the intake is in such a direction relative to the main stream as will prevent solid matter from entering the intake in large quantities. Experience has shown that prac-

tically all forms of intakes with a flow in the same general direction as the stream becomes seriously obstructed in a short time. To secure satisfactory results liberal provision must be made for grizzlies and removable screens as well as for sluicing out sand and other solid material as fast as it is deposited in the intake channel.

Some unusual features are presented in the operation of the company's plants, which are due largely to the topography and character of the country traversed by the flow lines and the character of the water as regards silt. The flow lines of both plants are located almost entirely on sidehill cuts in the mountainsides, which in general are relatively steep.

Open canals must be protected against large quantities of surface water during certain periods, and in the case of both the Cachapoal canal and Pangal pipe line account must be taken of sliding material, loose rocks and boulders. Considerable protection against the latter feature has been necessary for the wood-stave pipe line, in the form of wood covering and sheds, while a considerable portion of the line has been covered with earth fill with outer cover of stone riprap.

The natural formation of the adjacent country affords but little opportunity for the construction of settling basins. During high-water periods it is impossible to prevent large quantities of solid matter from going through to the wheels, resulting in unusually rapid cutting of parts of equipment subjected to water at high velocities. Wheel runners, gates, nozzles, etc., can therefore be counted upon for but relatively short life

FIG. 2. PANGAL POWER HOUSE AND PENSTOCKS

in service. This condition is to be expected in this section of Chile, and the only solution of the erosion problem to date appears to consist of a liberal spare supply of wearable parts, which must be kept on hand if satisfactory continuous operation is important.

In 1910 a 5,000-kw. power development with necessary substations was constructed for the operation of the company's plant. The capacity of this original station was increased first to 7,500 kw. and later to 10,000 kw., but has now been outgrown by the continual development of the mine to increase daily tonnage. To meet requirements for power on the basis of 10,000 tons of ore per day to which the plant capacity is being raised, extensive additions and betterments to the power system are now nearing completion.

The extent of the new power system and the location of power stations, substations and transmission lines are shown on the map reproduced in Fig. 1. At the

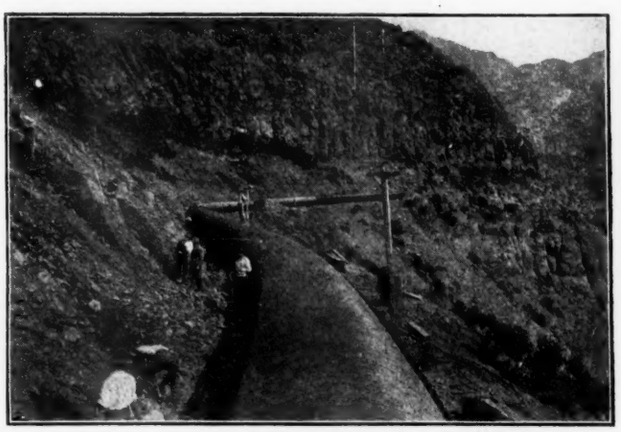


FIG. 3. SECTION OF PANGAL PIPE LINE

present time power is generated at Pangal and Coya stations at 2,300 volts three-phase 60 cycles. Voltage is stepped up to 33,000 volts three-phase 60 cycles for transmission. Pangal power is transmitted 5½ miles over double-circuit steel-tower lines to Coya, from which point the combined output of both plants is transmitted fourteen miles over double-circuit steel-tower lines to Sewell, where power is required for mining, ore treatment, smelting, etc. A tap from both of the Coya-Sewell lines supplies power for the new smelting and melting plant at Caletones. Provision is made in the design of stations and transmission lines for raising the voltage to 60,000. The capacity of the Coya station has been further increased by the addition of a new vertical unit and reconstructed to permit of raising the voltage from 33,000 to 66,000. The Diablo substation shown on the map will ultimately be replaced by the new concentrator substation.

The Pangal development, recently completed, uses water from the Rio Pangal River at an average net effective head of about 1,550 ft. By means of a dam and gate tower, water is delivered to the flow conduit. This gate tower is about 50 ft. present height, of octagonal form, about 36 ft. in diameter and provided with seven inlets protected by steel grizzlies. At the bottom of the tower is a cylinder gate about 100 in. in diameter connecting with the feeder conduit. For cleaning the intake tower, sluice valves are provided which connect with an auxiliary pipe under the dam and below the main feeder conduit. Two sets of stop logs are provided for each of the seven inlets, and there is a stiff-leg derrick on top of the tower for the convenient handling of the stop logs and racks. The flow line consists of about 37,000 ft. of 80-in. wood-stave and riveted-steel pipe laid to a uniform gradient of about 15 ft. to the mile. This conduit terminates in a differential surge tank 129 ft. present height, located about 4,000 ft. from the power house, and shown at *X*, Fig. 2. A

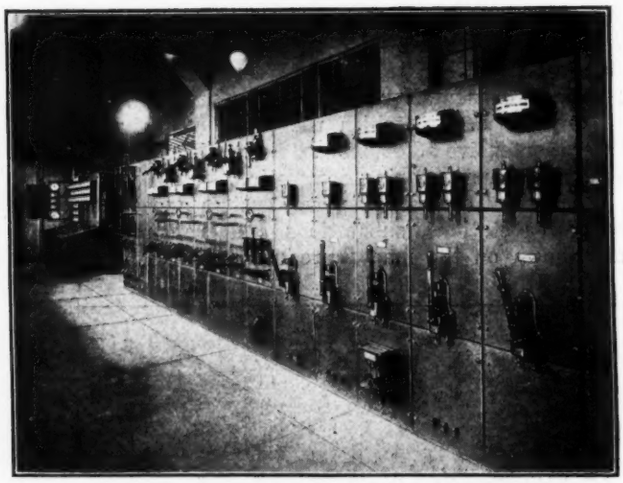


FIG. 4. SWITCHBOARD, PANGAL POWER HOUSE

typical view of the flow line is shown in Fig. 3. The surge tank is also provided with a connection for the penstock system, which, starting with a single 78-inch line, branches to two 46-in. lines. Each 46-in. line then branches to two 30-in. lines for connection to the four units in the power house. Valves are provided in the 30-in. lines where they branch from the 46-in. lines, also at the end of the 30-in. lines in the plant. Provision is made throughout for raising the head an additional 70 feet.

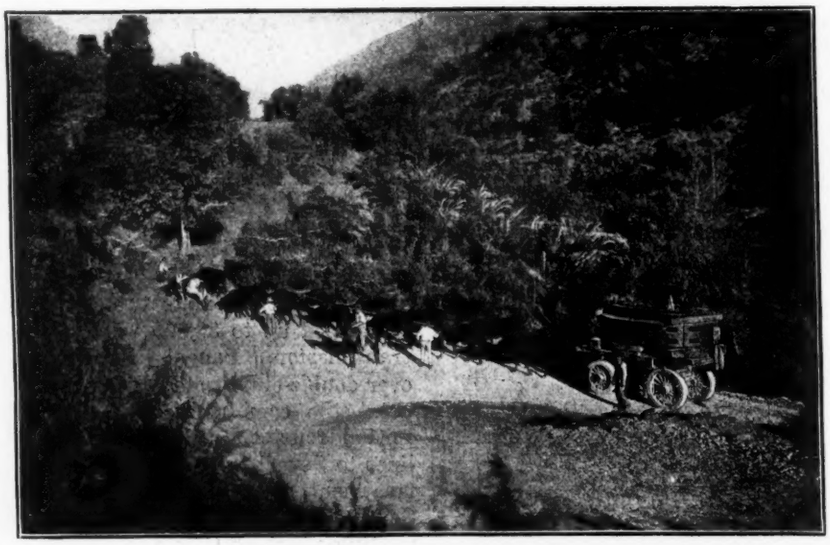


FIG. 5. TRANSPORTING SECTION OF MAIN PANGAL GENERATOR

While the ultimate plant will consist of four 5,600-kw. units, two units only are connected for operation at the present time, with No. 3 under construction. The waterwheels are of the horizontal tangential impulse type direct-connected to 2,300-volt three-phase 60-cycle 360-r.p.m. generators with direct-connected overhung exciters. Each exciter has a capacity sufficient for exciting two of the generator units. Fig. 2 is a general view of penstocks and exterior view of the plant. Only two of the penstocks are in place.

The transportation of the heavier pieces of machinery to this plant presented some difficult problems on account of steep grades and sharp turns encountered on the road leading to the site. Fig. 5 gives a view of a half-section of one of the main generator stators being worked into position for making a hairpin turn, which it will be noticed is being accomplished by driving the animals well up on the mountainside.

The Coya development utilizes water from the Rio Cachapoal at a net effective head of 440 ft. This plant has a flow line about 40,500 ft. in length. It is composed entirely of open canal except for short sections of tunnel and wood flume. The intake arrangement is located at one end of the dam and is controlled by means of standard vertical sliding gates opening into the canal. Just below the intake is a sand box approximately 50 x 80 ft., 6 ft. deep below the normal canal bottom. The bottom of this sand box is provided with numerous sluicing outlets which empty into pipes that conduct the water and sluiced-out material to the river.

The diversion dam is equipped with a rolling gate in the form of a steel-plate cylinder about 22 ft. long and 8 ft. in diameter. This steel cylinder is placed between concrete piers and slung on steel cables which connect with a power-operated hoisting arrangement above and to one side of the gate. This form of gate has been found to be free from operating troubles due to material piled up behind the dam, and to operate satisfactorily under all existing conditions. It serves the joint purpose of relieving the spillway during high water and of making adjustments at other times. The canal terminates in a small forebay from which separate penstocks lead to the five units in the plant below. Of the present units four consist of horizontal turbines direct-connected to 2,300-volt three-phase 60-cycle generators having a normal capacity of 2,500 kw. each, while the fifth is a vertical turbine-driven unit rated at 5,000 kw., making a total normal generating ca-

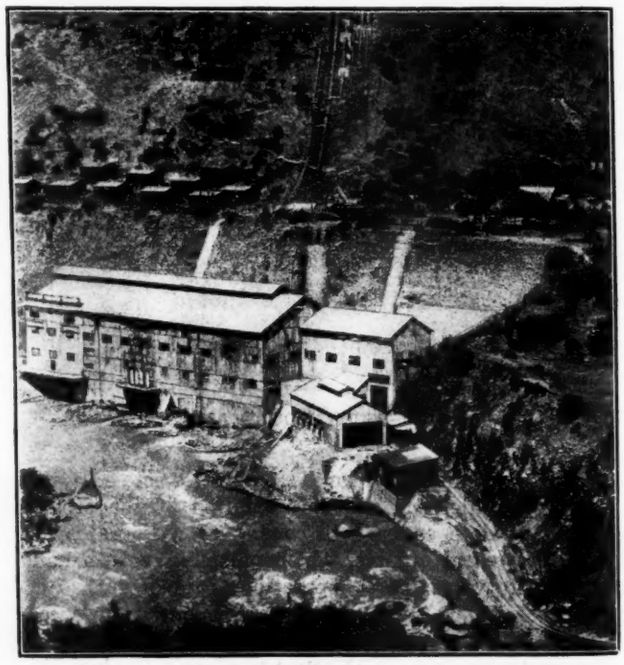


FIG. 6. EXTERIOR VIEW OF COYA POWER HOUSE

pacity of 15,000 kw. This includes some spare capacity, the normal output averaging somewhere between 12,000 and 14,00 kw. Three-phase transformer units are used at this station, also at the Pangal station and at all substations to raise and lower the voltage. A general exterior view of the Coya plant is shown in Fig. 6, and an interior view in the headpiece.

Continuity of operation in these plants is of the utmost importance on account of the character of the load. The load factor is very high, approximating 100 per cent throughout the day, so that equipment must be maintained in first-class operating condition at all times. By means of synchronous condensers at the concentrator substation and synchronous motors at other points later described, it is expected to maintain between 90 and 95 per cent power factor at the generating stations at practically all times.

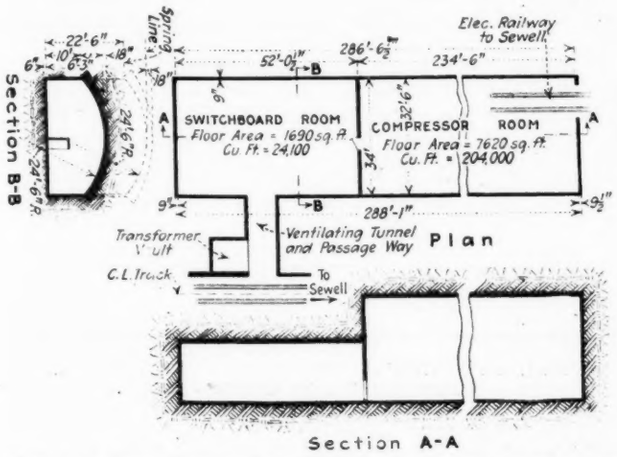


FIG. 7. SECTIONAL VIEWS THROUGH MINE SUBSTATION

The transmission lines from Pangal to Coya and from Coya to Sewell are both of double-circuit steel-tower construction, having two circuits of 00 and 0000 copper conductor respectively.

The power facilities at the new Caletones smelting and melting plant now under construction will consist of an outdoor substation with steel structure for switching equipment and two 5,600-kw. three-phase outdoor-type water-cooled transformers which will reduce the line voltage from 33,000 volts to 2,300 to feed the main busbars of a combined indoor distribution substation and machinery house.

In this building there will be three 1,700-hp. and three 800-hp. synchronous-motor-driven turbo-blowers operated at 3,600 r.p.m. for the supply of air to furnaces and converters. Two 500-kw. motor-generator sets will supply direct current at 250 volts to the yard railway and certain cranes requiring direct current. Two 1,000-kw. 2,300-volt to 550-volt three-phase water-cooled transformers are used for the general supply of power to motor-operated auxiliary equipment. The power supply for the entire Caletones plant will be controlled from this substation.

The concentrator substation, which is the principal center of distribution at Sewell, supplies power for crushing, milling, mineral separation, shops, townsite, etc. One of the novel features of this station is the arrangement of incoming line supports which was found necessary, in order to obtain sufficient clearance from previously existing structures. These are clearly shown in the upper left-hand corner of Fig. 8. Equipment at this station consists of two 5,600-kw. three-phase transformers and two banks of 2,500-kw. single-phase water-cooled transformers for the supply of power for crushing, milling and auxiliary equipment at 550 volts, and two 5,000-kw. three-phase transformers which feed the mine substation and local townsite distribution at 6,600 volts. There are also two 2,500-kva. synchronous condensers for power-factor correction and one 1,000-kw. motor-generator set used jointly for power-factor correction and for the supply of direct current at 275 volts for operation of the mine railway.

One of the principal problems in connection with the station's design was the arrangement of outgoing feeders to the mill, requiring, ultimately, nearly 15,000-kw. 550-volt three-phase 60-cycle current. Underground tunnels were finally adopted as representing the most satisfactory solution, as this plan had the advantage of permitting the use of a large amount of cable formerly run overhead on poles, but which was not in satisfactory condition for installation in underground conduits. Overhead feeders proved to be out of the question on account of their obstruction to valuable yard space and because of difficulty in taking care of dead-end stresses at the mill end.

The mine substation presents some unusual features from the standpoint of location and construction difficulties. The space occupied by this station, which is underground about 4,000 ft. inside the mine, was excavated out of solid rock. This was accomplished by first excavating throughout the entire length of the station a tunnel of such proportions and at such an elevation as would permit of concreting the roof, to seal in place and prevent rock from falling during further construction operations.

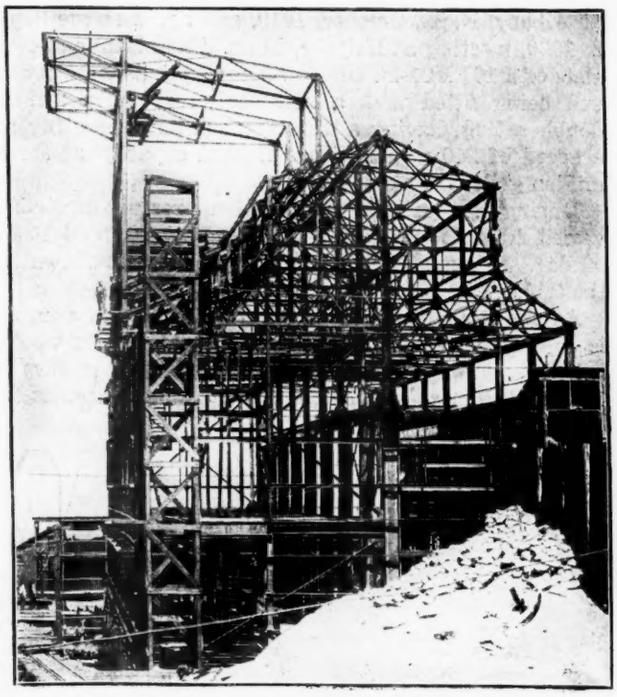


FIG. 8. STRUCTURAL-STEEL FRAME FOR CONCENTRATOR SUBSTATION

The roof having been completed, the floor of the original tunnel was gradually lowered by taking out

material until the floor elevation was reached and the concreting of the side walls completed. The general dimensions of this station and the extent of excavation involved may be seen upon reference to the sketch shown in Fig. 7.

Primarily, the mine substation supplies compressed air for mining purposes. It also supplies direct current for the mine railway and alternating current for mine hoists, auxiliaries and lighting. This substation equipment consists of two 2,500-kw. 6,600-volt to 2,300-volt three-phase water-cooled transformers, two 4,000-cu.ft. compressors driven by 900-hp. 2,300-volt three-phase synchronous motors, two 100-kw. motor-generator sets for exciting the synchronous-motor fields and one 500-kw. and one 200-kw. motor-generator set for the supply of direct current to the mine railway at 300 volts. Power supply for this station is by means of two three-conductor steel-armored cables about 9,000 ft. long from the concentrator substation.

Duplex Unaflow Pumping-Engine Water Valves

Considerable interest has been created by the performance of a unaflow simplex pumping engine under test. It is the first of its type and was installed at the Porter Avenue water-works pumping station, Buffalo, N. Y. A paper regarding this unit was presented at the meeting of the American Water Works Association at Albany, N. Y., October, 1919, and again at the Sept. 8, 1920, meeting at Holyoke, Mass. The steam end consists of a 13½ x 21-in. Unaflow steam cylinder, the water end being fitted with a new design of valve and is double-acting, having a 9-in. plunger and operating at a speed of 210 r.p.m. with a normal capacity of three million gallons per day.

During the test the only station pressure available varied from 200 to 225 lb. gage and superheated 10 to 20 deg. A summary of a number of tests is shown in the table.

At the high speed at which this engine is run, it is evident that the ordinary type of water valve would not prove satisfactory, and that in order to take advantage of the most economical speed an improvement in valve construction would be necessary. The design of valve used in the pump is shown in Fig. 1. A soft-rubber valve seat, *A* is reinforced by the copper ring *B*. The metal valve *C* is made saucer-shaped with a spring pressure on one side working against the water pressure on the other. As the valve is of spider design, the discharging water not only escapes past the outer edge of the valve, but also finds a passageway through the opening between the outer and center portion of the valve. As the valve seal is tapered, the water is discharged through the valve at an easy angle,

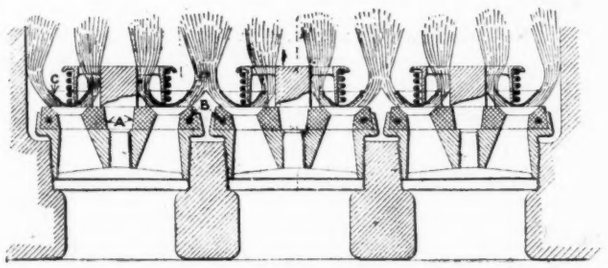


FIG. 1. DESIGN OF PUMP VALVES AND VALVE DECK TO OPERATE AT HIGH SPEED

which reduces the friction. The path of the water is shown in Fig. 1.

The Monongahela Water Co., of Elizabeth, Pa., has purchased a 15 and 15 and 7¼ x 16-in. duplex unit, Fig. 2, having a capacity of three million gallons per 24 hours at a speed of 193 r.p.m. Dry saturated steam at 150 lb. gage will be used.

SUMMARY OF TESTS OF UNAFLOW PUMPING ENGINE

	Date of Trial		
	Aug. 25		Aug. 28
Steam pressure at throttle, lb. gage	205.0	209.0	216.0
Steam temperature at throttle, Deg. F.	426.0	428.0	430.0
Superheat at throttle, deg. F.	36.0	36.0	36.0
Vacuum, inches mercury	26.5	26.3	25.8
Total head, feet	249.5	302.5	366.7
Rev. per min.	210.0	207.5	208.0
Duty million foot-pounds	128.3	131.5	132.0
Average m.e.p. pounds	39.3	46.0	57.8
Indicated hp.	118.8	137.8	173.5
Steam per I hp.-hr. (lb.)	13.6	13.5	13.3
Efficiency, per cent	88.0	90.0	87.2
Capacity per minute, (plunger discharge)	164.6	1,630.0	1,633.0

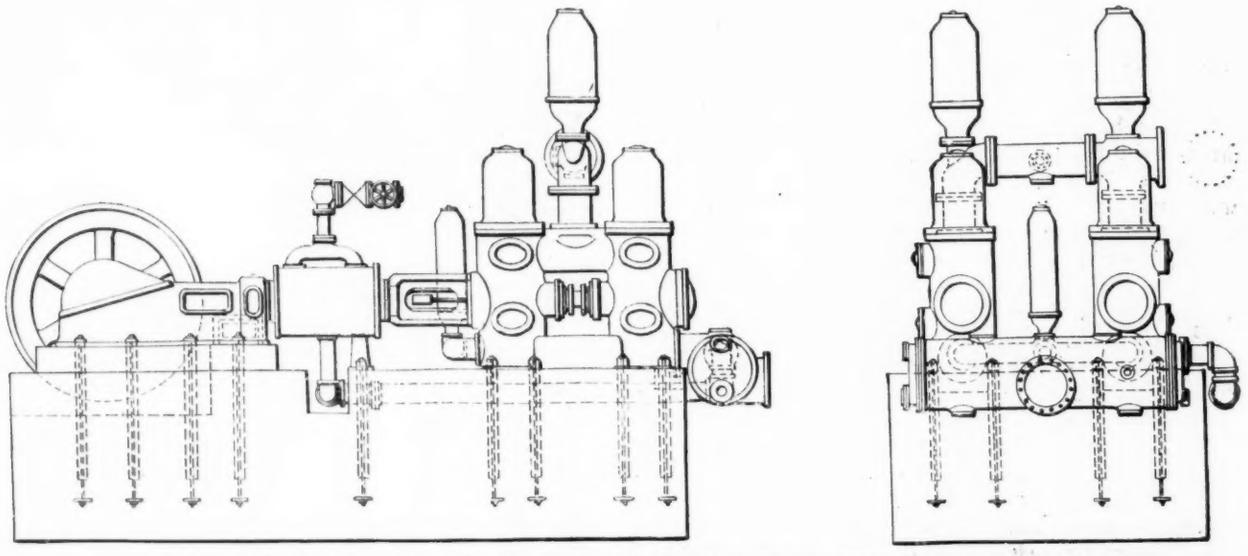
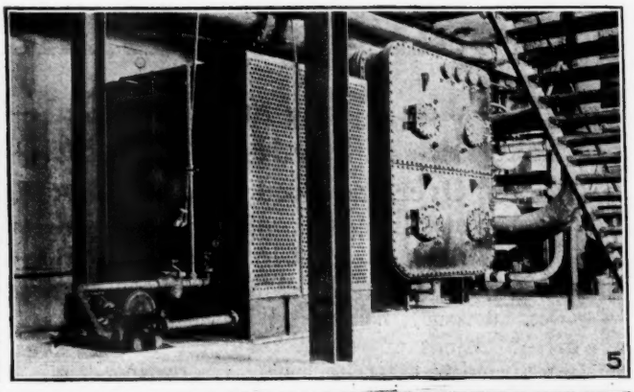
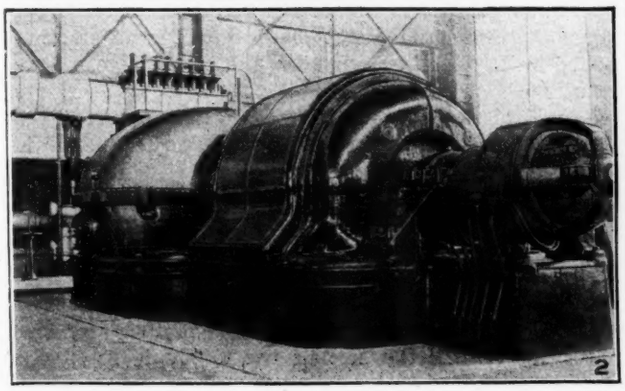
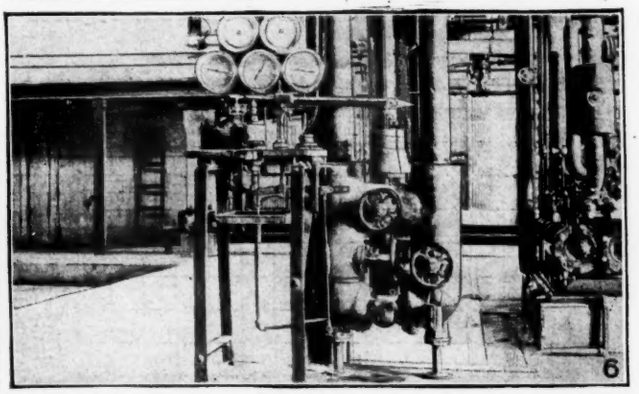
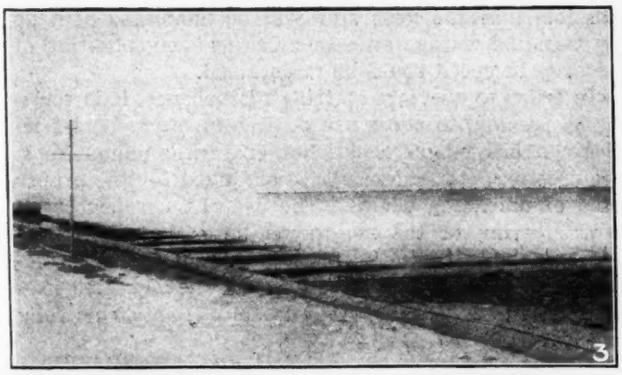


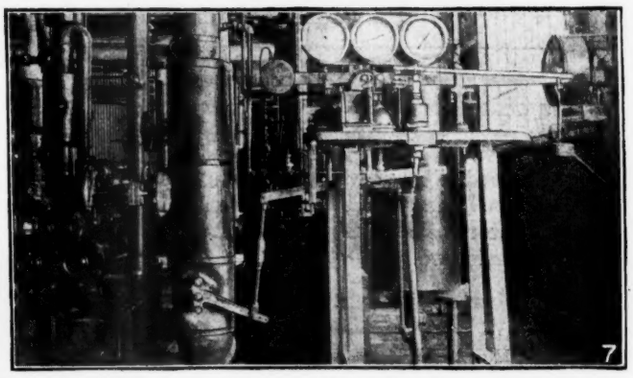
FIG. 2. SIDE AND END ELEVATIONS OF DUPLEX UNAFLOW PUMPING ENGINE DESIGNED FOR THE MONONGAHELA WATER CO.

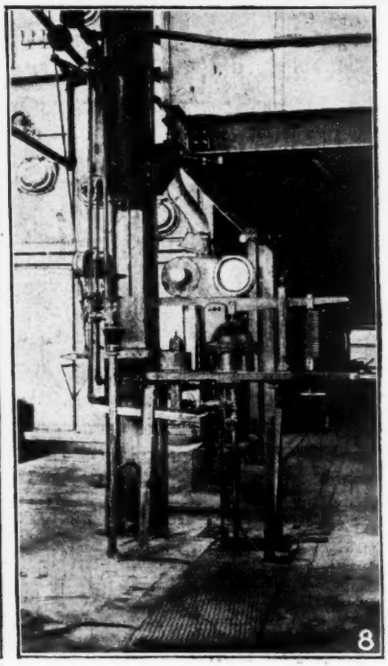












Views of the Power Plant of the New Cornelia Copper Co., Ajo, Ariz., a Notable Oil-Burning Plant

FIG. 1. MAIN SWITCHBOARD

FIG. 2. CURTIS 7,500-KW. TURBO-GENERATOR

FIG. 3. COOLING POND, 150 x 400 FT.

FIG. 4. BOILER PLANT SHOWING FUEL OIL AND ATOMIZING STEAM HEADERS ATTACHED TO BOILER FRONTS

FIG. 5. AIR WASHER FOR TURBO-GENERATOR

FIG. 6. FUEL-OIL REGULATOR

FIG. 7. ATOMIZING STEAM REGULATOR

FIG. 8. DAMPER REGULATOR

Application of Induction Motors—II

Current Taken During Starting Periods—Capacity Supplying Motor Sufficient To Take Care of Starting—Will Motor Operate at Its Full Rated Load?—Heavy Overloads and Severe Mechanical Shocks—Plugging of Motor

By FRAZER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

FIVE features were taken up in the previous article (Oct. 26 issue), namely: What is the motor to drive? Kinds of rating. Will the motor have sufficient torque to start its load? If starting conditions are severe, how much actual torque is required to start the load? What will be the length of the period of acceleration? In this article five more of the sixteen points on motor installation outlined in the first installment are considered.

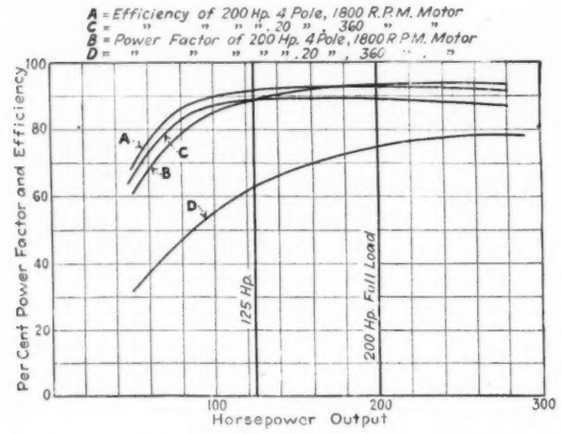


FIG. 1. COMPARATIVE CURVES OF HIGH-SPEED AND LOW-SPEED INDUCTION MOTORS

6. If the Motor Is of the Squirrel-Cage Type, Will Excessive Line Current During the Starting Period Be Objectionable?

Sudden large demands for power from a system of relatively small capacity as compared to the motor tend to create line disturbances that may be objectionable. If the source of supply feeds a power load, a lighting load or both, sudden large fluctuations in load, such as may be caused by the starting of a squirrel-cage induction motor, create fluctuations in the voltage provided there is no form of automatic regulator in the field of the generating equipment. The variations in these fluctuations will depend to a great extent on the relative capacities of the motor and the generating equipment, also on the load and power factor of the load already being carried by the generator. The variation in voltage may become great enough not only to cause a violent flickering of the lights on the circuit, which may be objectionable to the point of being prohibitive, but also to knock out other induction motors already connected to the system.

If there is sufficient capacity supplying the motor to take care of the starting period, but if the relative ratio of motor size to generator size is small, better and more stable operation may be had by the use of a voltage regulator in the fields of the generating equipment. If, on the other hand, the voltage cannot be kept within reasonable limits even with the regulator, some other type than the squirrel-cage motor will have to be considered.

Another feature in connection with the large current taken by the squirrel-cage motor during the starting period is that the line copper or the feeder copper may be of such size and length as to create an excessive voltage drop at the motor terminals, thus reducing the starting torque value to the point where the motor is unable to start its load effectively.

7. Is There Sufficient Capacity Supplying the Motor to Take Care of the Starting Period?

As has already been brought out, the squirrel-cage motor in starting draws a large current at a very low power factor. If the size of the motor is relatively large as compared to the prime-mover equipment, it is possible that the generator will be unable to hold up its terminal voltage even though the ideal condition of no drop in speed could be maintained.

In order to alleviate starting disturbance, it is sometimes possible to make use of certain mechanical friction clutches, magnetic clutches, etc., while pumps, fans, compressors, etc., can easily be arranged for the proper kind of unloading device. The use of such devices allows starting of the motors on lower taps with less current and with the ultimate result of less line disturbance. In any event the question of connected load in relation to prime-mover capacity should be fully considered.[1]

8. Will the Motor Operate at Its Full Rated Load?

As the power factor of the average induction motor drops off rapidly as the load falls off, and if there are a number of such machines operating at greatly reduced loads, it is seen that a condition prevails making for a power demand at excessively low power factor.

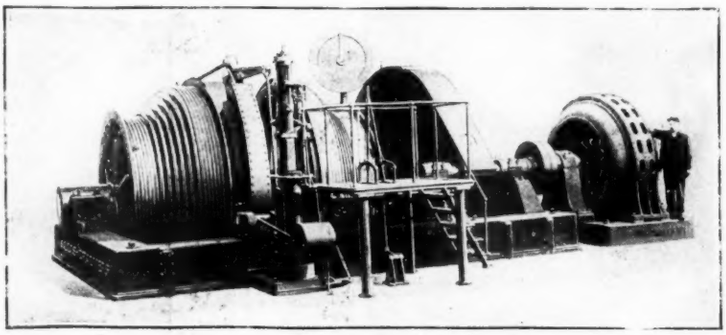


FIG. 2. APPLICATION OF A FLEXIBLE COUPLING MOTOR AND GEAR UNIT ON A HOIST

[1] For a fuller discussion on this point see article, "Connected Load Versus Generator Capacity," by the author, *Power*, Aug. 3, 1920.

The inherent characteristics of induction motors of different speeds is not often fully appreciated and realized. Fig. 1 shows the curves for motors of two entirely different speeds, namely: 1,800 r.p.m. and 360 r.p.m., a 4-pole and a 20-pole motor respectively. The slow-speed motor, owing to its large magnetizing current and high reactance, is a machine of poorer characteristics than the high-speed motor. The efficiency curves for either the high-speed or the low-speed motor are more or less flat over the range of load from $\frac{1}{2}$ to $1\frac{1}{4}$, so that working at reduced loads does not make a large difference in efficiency. On the other hand, the effect of working at, say 125 hp., instead of the normal load of 200 hp. shows a large falling off in the power factor, which is much greater for the slow-speed motor than for the high-speed motor. It is therefore advantageous to work motors as near to their full rated load as possible, not only to obtain the greatest true energy output from the generating apparatus, but in cases where power is bought, to avoid being penalized by higher power rates due to the low power-factor condition.

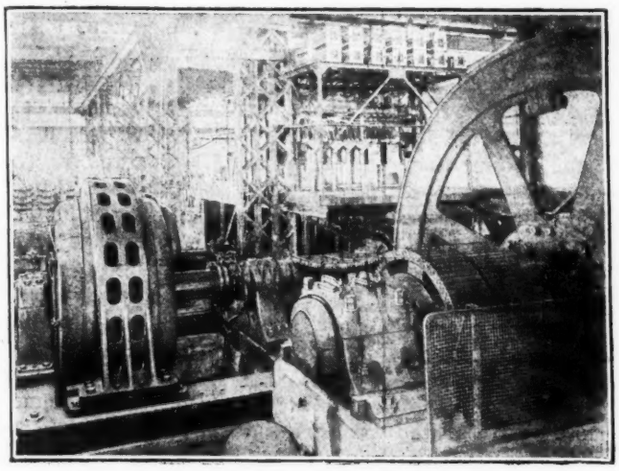


FIG. 3. APPLICATION OF CHAIN DRIVE BETWEEN MOTOR AND DRIVEN MACHINE

When squirrel-cage motors are operating underloaded, great care must be taken to make certain that the use of smaller machines in place of underloaded machines will deliver the proper amount of torque for starting the load. Oftentimes squirrel-cage motors have been installed that were larger than necessary for the running-load conditions in order to take care of the starting conditions, but in such cases the use of smaller slip-ring motors would appear to be a much more desirable procedure, since they could easily meet the starting conditions.

9. Will the Motor be Subject to Heavy Overloads and Severe Mechanical Shocks?

Because of its peculiar inherent characteristics, the induction motor is a machine having a relatively small air gap; that is, the clearance between the rotor iron and the stator iron is small compared with that of other types of rotating electrical machinery. The greater the air gap is made the lower the power factor becomes, so that the clearances are made such that from an electrical standpoint the power factor remains high, while from a mechanical standpoint the operation is absolutely reliable. This clearance is usually measured in thousandths of an inch, so it is important that the proper tolerances in the bearings be maintained and that the rotor be kept central with respect to the stator at all times.

For the foregoing reasons any load action with a tendency to injure the bearings should be given special consideration. For instance, the use of gear pinions mounted directly on the motor shaft, on the larger sizes of motors, say 100 hp. and above, is not only likely to affect the bearing tolerances, but the severe and continual mechanical vibrations of the load and the gears themselves will in time tend to crystalize soldered joints, loosen screws, cut through insulation, loosen laminations, etc. A flexible coupling, Fig. 2, interposed between the motor and the gear unit, has been found to obviate the troubles otherwise likely to occur.

On the other hand, the use of a chain driving from a pinion mounted directly on the motor shaft, Fig. 3, even for rolling-mill work, has been found to work out satisfactorily. In such a drive the severe load shocks and jolts are absorbed by the flexible chain and the proposition is entirely different from that of the gear.

Again, any driven machine having a side or end thrust when under the load should never be rigidly coupled to the motor unless provision is made outside the motor for taking care of this thrust. As a matter of fact it is always advisable, as in Fig. 4, to interpose a flexible coupling between the motor and the driven machine when the two are direct-connected.

If the power demands require heavy peak loads of short or long duration, the motor must be capable of taking care of these without dropping its speed on account of insufficient torque. If the nature of the load is more or less regular and fairly well known, it is often possible to effectively use a flywheel and cut down on the size of the motor and incidentally to reduce the power bill where energy is bought on a maximum-demand basis.

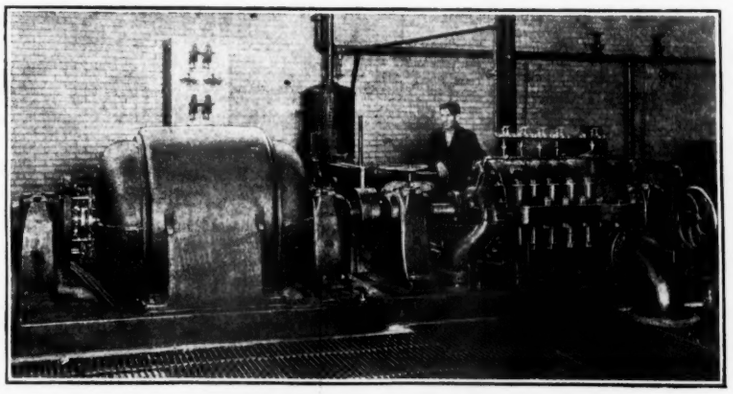


FIG. 4. APPLICATION OF A FLEXIBLE COUPLING BETWEEN MOTOR AND PUMP

The effect of such an arrangement is shown by Fig. 5, the full lines denoting the power demand and motor load without flywheel, the dotted lines denoting the motor load with flywheel. The straight-lined portion represents the energy given up by the wheel, which is approximately equal to the cross-sectioned area representing the power necessary to bring the wheel back up to speed. The use of the wheel reduces the peaks

and averages up the load, thus relieving the motor. The flywheel can be used only under conditions where the load is definitely known to fluctuate between a maximum and a minimum value for definite periods of time, with definite periods of no-load or light-load conditions allowing suitable time for restoring energy to the wheel.

10. Will the Motor Be "Plugged"?

Oftentimes the service, while of a highly pulsating and intermittent nature, such as to be found in rubber mills, balanced hoists, steel mills, etc., is such that continuous rated motors are used. This service frequently requires the motor to be "plugged"—that is, reversed from full speed in one direction to full speed in the opposite direction—and this, combined with the maximum torque feature so frequently needed, requires a more or less special motor to suit the conditions involved, but one classified under the general heading of continuous rating.

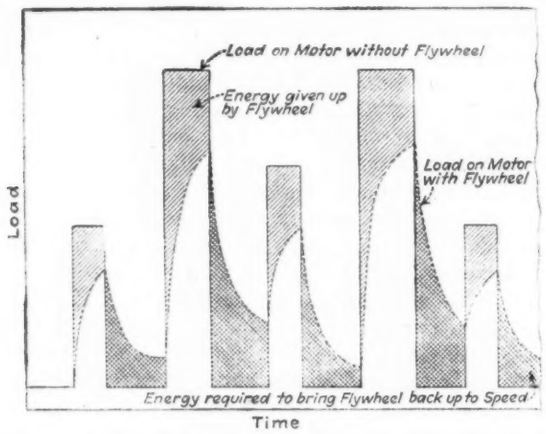

Load on Motor without Flywheel
Energy given up by Flywheel
Load on Motor with Flywheel
Load
Energy required to bring Flywheel back up to Speed
Time

FIG. 5. CURVE SHOWING GENERAL EFFECT OF A FLYWHEEL ON THE LOAD TAKEN BY A MOTOR

Induction motors used for reversing service are subjected to very different electrical and mechanical stresses from those used only for continuous-duty service in one direction of rotation. Ordinarily, motors when operating in one direction, upon being brought to a distinct stop and then started up in the opposite direction of rotation, are not subject to any greater stresses than the continuous-running motor. The only difference is that the repeated starting and stopping subjects the motor to more frequent electrical stress than is otherwise obtained. If, however, the motor is reversed while running at normal speed in one direction to full speed in the opposite direction, the conditions are entirely different.

In the rolling of steel it frequently happens that a cold billet will stick, thus necessitating either the stopping of the motor before backing out or immediate "plugging." In rubber mills as also in the steel mills, "plugging" is used as a precautionary measure to safeguard human life and prevent an operator being drawn into the rolls if he should become caught in the material or tables leading to the mill. For hoist work the ideal condition is always one of coming to a full stop before reversing, but emergency conditions and the inching back and forth to obtain correct levels are the equivalent of "plugging" service.

"Plugging" is also used extensively for bringing apparatus having large inertia, such as flywheel motor-generator sets, quickly to rest. Not only is it a desirable operating feature, but when it is considered that such apparatus will often run for an hour or more when disconnected from the source of supply before coming to rest, the question of a quick stop necessitates this means as an emergency method if for no other reason. What would otherwise take an hour or more can be accomplished by "plugging" in the space of ½ to 2, 3 or 4 minutes, depending largely on the inertia and on the limits to which the reverse torque is confined.

Consider first the electrical stresses. It is generally known that a slip-ring type induction motor has a voltage across the slip rings of its rotor, which is a maximum at standstill and a minimum, or zero, at synchronous speed. This is shown by the curve *AB*, Fig. 6, and represents the dielectric stresses in the rotor under the most prevalent and usual method of operation found in practice.

If the motor is running at full speed in one direction of rotation and is reversed, or "plugged," by changing the primary connections the dielectric stresses in the rotor are doubled, curve *BC*, Fig. 6, so that it is now seen that the rotor insulation is subjected to a much greater stress than when working under ordinary conditions. Recognizing these conditions, the American Institute of Electrical Engineers, in their standardization rules, call for dielectric tests which meet the need for additional insulation for this particular kind of service. The rule given is as follows:

The secondary windings of wound rotors of induction motors shall be tested with twice their normal induced voltage, plus 1,000 volts. By normal induced voltage is here meant the voltage between slip rings on open circuit at standstill with normal voltage impressed on the primary.

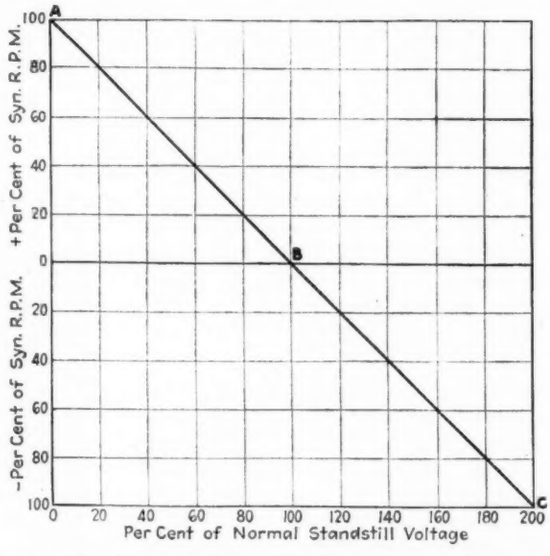


FIG. 6. CURVE SHOWING EFFECTS OF PLUGGING SLIP-RING TYPE MOTOR

When induction motors with phase-wound rotors are reversed while running at approximately normal speed, by reversing the primary connections, the test shall be four times the normal induced voltage, plus 1,000 volts.

"Plugging" service therefore requires motors having specially insulated rotors in order to safely withstand the severe service conditions as well as the dielectric test conforming to the standardization rules of the American Institute of Electrical Engineers.

Consider, secondly, the mechanical stresses. It is self-evident that reversing from full speed in one direction to full speed in the opposite direction imposes strains not ordinarily encountered. For this reason it is sometimes necessary, especially on the larger units, to double-key the rotor spider to the shaft, dowel or key the end heads that support the rotor coils to the spider, and to protect to a greater extent that portion of the rotor coil lying in the slot portion of the core against mechanical injury. It is also necessary in most cases to support the stator coils against mechanical movements and weavings due to the stresses set up, and where possible the air gap is made larger than usual on account of the severe service to which the bearings are ordinarily subjected. The nature of the work to be accomplished is such as to demand a motor of more rigid mechanical construction than is otherwise ordinarily required.

[*The next and last installment will consider the location of the motor; connection of the motor to its load; power requirements; local fire-underwriters' requirements; protection of motor; and selection of motor.*—EDITOR.]

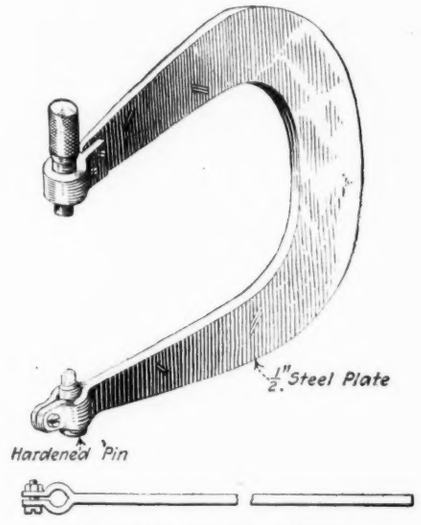
Alignment of Oil-Engine Main Bearings

In the manufacture of the modern oil engine the bearings are made up of babbitt-lined semicircular shells. These shells rest in housings formed in the engine frame. It is the practice to bore all the housings on a horizontal boring mill at one setting. They are then checked by a special fixture. The work is usually performed in a painstaking manner, and seldom does any housing show more than a few ten-thousandths out of alignment. The housings are filed and scraped until they test true. The bearing shells are all made of equal thickness, and, after being bedded in the housings, are checked for alignment by a test shaft. If any error appears, it is corrected by scraping of the babbitt.

After the engine is installed in a power plant, the bearings begin to wear. No matter how excellent the lubricating system may be, the wear starts as soon as the engine turns over. Since the babbitt linings in the several bearings are never of equal density the wear is by no means uniform. Varying pressures in the engine cylinders tend to increase the discrepancy in the rate of bearing attrition. If the flywheel weight is supported or partly supported by one of the end main bearings, this bearing will probably show a more rapid wear than the others. Oil-engine operators should recognize these facts and take proper steps to maintain the bearing alignment. Too many allow matters to drift until one or more bearings start to run hot. In most instances it is then too late to save the babbitt lining.

Just as there should be a regular schedule in grinding valves and pulling pistons, the engineer should test the bearings at stated intervals. It is difficult to give a rule as to the length of time elapsing between inspections; the operator is not unduly active if he arranges to examine the bearings every six months. To remove the bottom half of the bearing, it is only necessary to lift off the top half and turn the flywheel. The revolving shaft will draw the lower bearing from the housing. The thickness of the shell should be measured at both ends and at the center; several measurements should be taken at various points. If these measurements are the same, it is evident that the wear on the particular bearing has been uniform. If the measurements check with readings taken on the other bearings, the main bearings are in alignment. If one bearing shows that it is low, the engineer must decide his course of action. It is possible to shim up under this low bearing until it is as high as the other. If the difference is marked this is the best procedure; sheet steel make the best liners. If the variation is less than five one-thousandths of an inch, probably the best scheme is to scrape the other bearings, removing an amount of babbitt to compensate for the variation between the highest and lowest bearings. In cases where all the bearings vary, scraping is the only remedy.

Few engineers are equipped with a micrometer having a gap deep enough to take the length of a main bearing. In fact, no manufacturer carries such an instrument in stock, but a very serviceable one may be made in any machine shop. A piece of ½-inch boiler plate is cut to the form illustrated. At the base a hardened pin is turned up and inserted in an eye formed out of the steel plate. To the upper end of the plate is riveted and soldered the shank of a one-inch micrometer. The distance between the two arms of the yoke should not exceed three inches. This micrometer actually measures differences, but the results desired when measuring bearing shells are differences and not exact thicknesses.



MAIN-BEARING MICROMETER

That more attention should be given to bearings is evidenced by a recent crankshaft failure on a 500-hp. Diesel. On examination the shaft showed marked crystallization. When the alignment of the bearings was checked one was found to be $\frac{1}{32}$-in. lower than the others. The shaft had been unsupported between two of the cranks, and at each power stroke of these two cylinders it had bent. This bending, continuing for months at the rate of 350 times per minute, resulted in crystallization and final failure. In this breakage a loss of some $7,000, plus loss of operating time, is traceable to misalignment of the main bearings.

In the description of the Miami Oklahoma Diesel plant *Power*, Oct. 19, page 615, the horsepower rating of the engine was given as 385 hp. This was an error and should have been 500 hp.

Preventing Emulsification in Oil-Circulation Systems

By R. E. LANGSTON
Lubrication Engineer, Wayne Oil Tank and Pump Company

THE value of a complete system that permits the recovery of used oil, its purification and its delivery in a continuous stream, is recognized as the extreme limit in lubrication economy. The merits of a central oiling system depend altogether upon the recovery of the used oil and the ability of the apparatus to get it back into a usable condition.

In handling the lubrication to engines, turbines or high-speed power units, lubrication engineers have had to give considerable study to the problems arising from the emulsification of oil and water. We often hear it said that oil will not mix with water. This expression is common. But engineers know that oil will readily mix with water under favorable conditions. How permanent the mixture will be depends much upon the chemical composition of the oil, its degree of refinement and the mechanical action to which the oil and water are subjected.

Emulsified oil is not a good lubricant. That friction-reducing film cannot be maintained with an oil-and-water mixture. The formation of sludge is the product of an emulsion. It is a mixture of incorrect oil with water, dirt and mechanical impurities. Emulsification and sludge are responsible for more bearing trouble than is generally realized. An emulsion often becomes so thick that oil pipes are clogged and cause a failure of the oil supply. Water in the oil is not an aid to lubrication; it is a dangerous impurity which must be kept out, just as dust or dirt.

Central oil-circulation systems in modern power plants are coming into extensive use as a means for producing economy in oil consumption. The author discusses the kind of oil to use in such systems to avoid forming an emulsion.

A good mineral oil does not wear out mechanically and may be used over and over again. If it has been properly purified and all foreign impurities removed, it usually remains as good as new oil in every respect. But it must be carefully filtered and rid of water.

Entrained water, not free water, is the most troublesome impurity contained in used oil and offers the most difficulty to separation. More or less water is sure to find its way into the oil from the leaking stuffing boxes, cooling coils, or seals, etc., of the lubricated machinery. This water mixes with oil under conditions that are correct for the formation of an emulsion. The kind of water used, boiler compounds, speed and temperature of journals, as well as kind of oil, each has its effect upon emulsification. Conditions in the steam turbine are the most ideal for an intimate mixture, for here water and oil are churned at an excessive speed, during high temperature, and under heavy pressure. Because the steam turbine possesses such excellent emulsion-forming conditions, it is important that turbine oil should be of such character that it will rapidly separate under right treatment from the entrained water.

Nevertheless, any oil that possesses even a high resistance to emulsification will mix with condensation around a steam engine. The presence of heat and motion will cause the oil to unite with moisture. However, if these mixtures are permitted to remain in a state of rest, at a temperature sufficient to keep the viscosity of the oil greatly reduced and for a period of time, entrained water will settle out of the oil and make a complete separation. The proportion of water settled out of the oil in a given length of time is the measure of its resistance to emulsification.

In the selection of an oil to be used in a plant for bearing lubrication, and particularly one to be used in an oil-circulation and filtration system, care should be taken to specify an oil possessing a high demulsibility test, as well as the other necessary physical properties. A plant with a circulatory system, and means for recovery and using the oil indefinitely, can afford to use the best oil obtainable. The cost of the small amount of oil necessary to keep the system filled is nothing compared to the benefits that are obtained, such as economy in power and economy in operation of the system. Resistance to emulsification is just as much of a physical property to be demanded in specifications as is viscosity or flash point. It is a property given the oil by the manufacturer. An oil that is highly refined or is thoroughly purified will have a high demulsibility test which serves as the best proof of its degree of refinement. As a general rule a "pale" lubricating oil has been filtered more than a "red" oil and will not emulsify as readily. A good oil is distinguished not necessarily by its lightness of color, but by the amount of filtering given it in the refinery. The elimination of waxes from oil by more complete refining causes a decided increase in the ease with which the oil will separate from the water. Some oils become acid with long-continued use because of impure refining or because of absorbing acid from the metal with which they come in contact. The presence of acid will cause a rapid decrease in demulsibility. Other oils remain neutral and continue to be free from that emulsion-forming property.

The cause of this intimate mixing of oil and water is explained by various theories. Milk is a natural emulsion, composed of globules of butter fat coated with casein and suspended in water. In mayonnaise dressing the globules of oil are coated with the yolk of egg and suspended in vinegar. The object of the pharmacist in making permanent emulsions is first, to thoroughly divide the oil into globules and then surround each globule with an adhesive envelope to prevent them from reuniting. The lubricating engineer, on the contrary, desires that there shall be no substance present in the oil which might form an adhesive envelope in case the oil becomes finally divided. In other words, if nothing but pure oil and pure water are present any emulsion that might be formed will not be permanent.

To aid in the separation of the entrained water, an oil filter must be used which is so designed that the body of oil to be treated is held in an approximate state of rest and at a temperature sufficient to thin it and permit the spheres of entrained water to settle. With the assistance of a properly designed filter a good high-grade oil may be kept free from entrained water and other impurities and may be used a long time.

The need for a standard emulsification test has been of great importance, not only to the lubrication engineer, in the comparison of this property of oil, but to every operating engineer who uses a continuous oil-circulation system. If more oil was purchased according to specifications and each batch tested before accepted, it would not be so easy for an engineer to get an inferior grade.

The United States Bureau of Standards has anticipated this need of a standard emulsification test and has devised one that will give more uniformity to a laboratory analysis. But for an engine-room comparison of oils, the ordinary operating engineer may take 20 c.c. of oil and 40 c.c. of water in a small bottle, shake it vigorously, at a temperature of about 130 deg. F. for about five minutes, then let the mixture settle. If the samples are all given the same treatment, the comparison will be just as good for his purpose as an elaborate test. The highest possible demulsibility will be obtained if all the oil, 20 c.c., settles out in one minute; which, expressed in cubic centimeters per hour, equals 1,200.

$$\textit{Number of c.c. of oil settled out} \times \frac{60}{\textit{time in minutes}} = \textit{c.c. per hr.} = \textit{demulsibility.}$$

For example, if a demulsibility of 400 is specified, and the oil has not settled out in three minutes, it has failed to meet the requirements.

During a test with the best non-emulsifying oils there is apparently no true emulsion, but only a kaleidoscopic movement of bubbles. The test is one that any engineer can make and will be a wonderful help to the selection of a proper oil. Taken as a whole, according to their demulsibility, the majority of the oils on the market are either very good or very bad. For a non-emulsifying turbine oil, a demulsibility test of 300 is a good specification.

Engineers should protect their oiling systems against those conditions which cause choked oil pipes and the disastrous effects of insufficient circulation by eliminating all chances for the formation of an emulsion and sludge. Sludge is the "Jonah" of every turbine operator. It is caused by the emulsification of an incorrect oil with water and other impurities or the continued use of an oil without purification. Every circulatory oiling system is affected sooner or later by sludge if the impurities are not continually removed from the oil by means of a good filter. Every precaution should be made to prevent this danger, trouble and expense caused from emulsification, by combining the use of a better grade of oil with that of an efficient filtration system. Better lubrication will be obtained, maintenance trouble will be reduced to a minimum, and less oil will need to be purchased, for the life of the oil will be so greatly increased, and less evaporation losses will be had.

A good, reliable oil filter is the heart of a circulatory oiling system and will prevent sludging and dangerous emulsification.

Fig. 1 specimen is new unused oil. Fig. 2 specimen is used oil from a circulatory system, showing the sludge formation, the result of the emulsion of oil and water. The oil-coated water globules are shown entrapped in the oil.

After purification in a reliable oil filter this dirt and water will have been removed and the condition of the oil restored to that of the new unused oil. The photomicrographs show oil drops magnified 500 diameters.

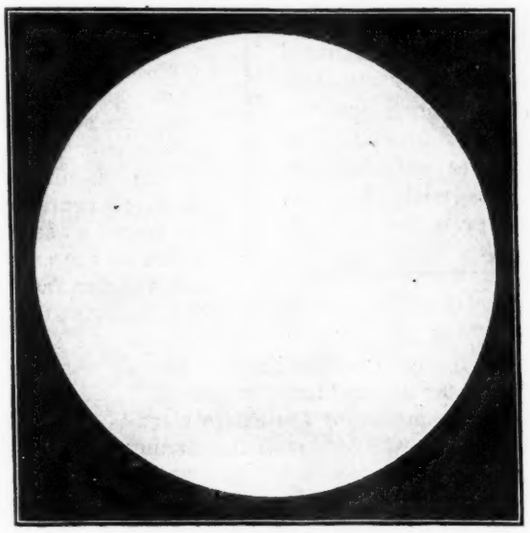


FIG. 1. CLEAR, FRESH OIL

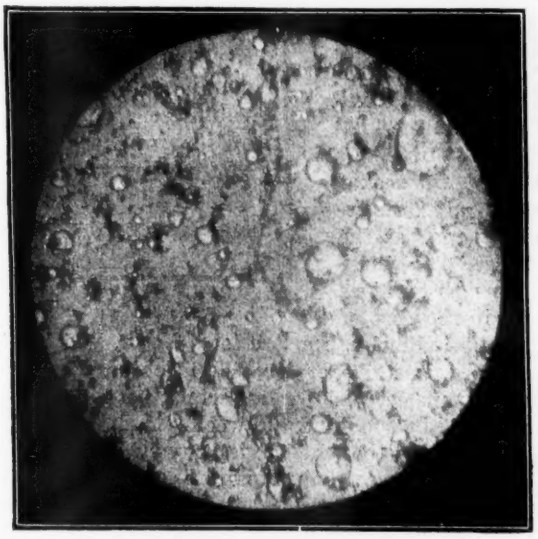


FIG. 2. EMULSION OF OIL AND WATER

MICRO-PHOTOGRAPHS OF LUBRICATING OILS, FIVE HUNDRED DIAMETERS

The British Board of Trade and the Privy Council have appointed special committees to make an investigation of available "white coal" resources. An official Water Power Resources Committee has already examined and reported favorably upon nine separate schemes of water-power development in the Scottish Highlands. These nine schemes, it is estimated, would yield an aggregate of 183,500 hp. at a cost much below that of generating power in Scotland by the use of coal.

Motor-Driven Ice Plants—Electrical Consumption Per Ton of Ice

By JOHN E. STARR*

THE cost for power alone per ton of ice made, as distinct from the total cost, is a subject that admits of fairly close analysis, especially in view of the large amount of statistics now available from electrically driven plants where the power output can be daily accurately measured.

With coal, oil or other source of power the results are not so easily arrived at on account of the great variation in quality of coal, methods of firing, cost of labor, etc. The increasing use of electricity from central stations renders the cost in kilowatt-hours in actual practice easily obtainable, and if one knows the kilowatt-hours used, he has only to reckon the local rate for electricity to get at the cash cost. The variation in cost lies mainly in the cost of operating auxiliaries, and the load factor, which latter includes the time of operating the machine, whether on a steady monthly load for a certain period, the time of year of the period and the weekly load factor. For, with electricity, the charge is usually based on the maximum load occurring during the week computed from short-time meter reading taken by the electric company—all of which argues for a low weekly maximum demand, a full load for each month while the plant is running at all and a run of the largest number of months possible at full load.

Variation in cost lies mainly in cost of operating auxiliaries, and the load factor. Under usual conditions of pressures, loads, temperatures, and volumetric efficiency, 48.5 kilowatt-hours per ton of ice is the usual good result as found. The compressor should have a separate current meter. The cost of operation varies with the seasons, especially where cooling-tower water is used.

Much depends on the local conditions as to water supply, both as to temperature and quality.

At 185 lb. gage head pressure and 30 lb. absolute, or about 15 lb. gage back pressure, and the average volumetric efficiency obtaining in good practice, and assuming that the ice is made regularly on a good weekly load factor, it takes, as shown by the table 48.5 kilowatt-hours to make a ton of ice. If conditions such as sufficient tankage and cannage will allow, 20 lb. gage back pressure and 185 lb. gage head pressure may be used. The kilowatt-hours by this increase in back pressure can be reduced to 44.1 per ton of ice for the machine alone. If electricity cost 1½c. per kw.-hr., the saving by increased back pressure would amount to $6.60 for each 100 tons of ice made, or a gain of about 9 per cent as to this item alone. If in the cooler months the head pressure be reduced to, say, 145 lb. and the back pressure held at 20 lb. gage, the machine electrical input per ton will be reduced to 35.16, and so on. But the power cost to run the compressor is not the total power cost. It takes electricity for water pumping, for lighting, for cranes and for air and brine agitation, and these are as much the power cost of ice as is the machine cost. It is, of course, well to have a separate meter on the machine alone and so facilitate the analysis of power costs and the separation of the machine cost from the balance. In this case the table is directly usable as it stands, as far as machine costs go.

Where one meter for the entire plant is used, a percentage, which will vary with the circumstances in each case, depending on the water used and its temperature, the amount of lights, etc., must be added to the table.

The cost of operation also varies with the season, especially where tower water is used, as this will be colder in the spring and fall months than in the summer, and therefore the head pressure will vary.

The combined operation of five plants using tower water varied from 27.7 kw.-hr. per ton in December to 50.6 in July for all purposes, including short storage and lighting, and the average for the year was 41.6; 18 plants averaged 51.12 for the year.

One plant averaged 57 kw.-hr. per ton for the year, another 58.8 kw.-hr. and a smaller one (50 tons max.) 62.2 kw.-hr per ton for the year. Another plant in 1914 made 15,000 tons at a low suction of from 12 to 15 lb. and brine temperature of 8 to 12 deg. F., operating from June to October, and averaged 55.0 kw.-hr. per ton, running as high as 66 kw.-hr. per ton for one month for all purposes.

POWER IN KILOWATT-HOURS PER TON OF ICE

Suction Pressure Head Pressure Gage	5 lb. gage Kw.-hr. per Ton		10 lb. gage Kw.-hr. per Ton		15 lb. gage Kw.-hr. per Ton		20 lb. gage Kw.-hr. per Ton		25 lb. gage Kw.-hr. per Ton	
	Refr.	Ice	Refr.	Ice	Refr.	Ice	Refr.	Ice	Refr.	Ice
145	35.52	54.6	30.07	46.24	25.68	39.5	22.87	35.16	20.259	31.16
150	36.5	56.1	30.9	47.5	26.4	40.65	23.6	36.2	20.9	32.4
155	37.4	57.6	31.7	48.8	27.2	41.8	24.3	37.35	21.6	33.55
160	38.4	59.1	32.55	50.2	28.0	42.9	25.1	38.46	22.3	34.7
165	39.35	60.6	33.4	51.5	28.8	44.05	25.8	39.6	23.0	35.85
170	40.3	62.0	34.2	52.9	29.55	45.2	26.5	40.7	23.65	37.0
175	41.3	63.4	35.2	54.2	30.35	46.3	27.2	41.85	24.3	38.2
180	42.2	65.05	36.1	55.5	31.15	47.4	27.95	43.0	25.0	39.35
185	43.2	66.5	36.9	56.9	31.9	48.5	28.7	44.1	25.7	40.5
190	44.1	68.0	37.8	58.2	32.7	49.7	29.4	45.2	26.4	41.7
195	45.1	69.4	38.6	59.5	33.45	50.8	30.1	46.3	27.05	42.8
200	46.05	70.9	39.5	60.8	34.2	51.95	30.85	47.4	27.7	44.0
205	47.04	72.43	40.368	62.16	35.04	53.088	31.58	48.57	28.40	45.12

*Starr Engineering Co., New York City.

In the following year the tank surface and can ratio was increased and a higher back pressure of 22 lb. with brine at 18 deg. F. was used, with a result of 40.5 kw.-hr. per ton for the whole year, and 47.7 kw.-hr. per ton for August. This consumption was for all purposes, including auxiliaries. The higher back pressure made a gain of about 9 per cent in operative cost.

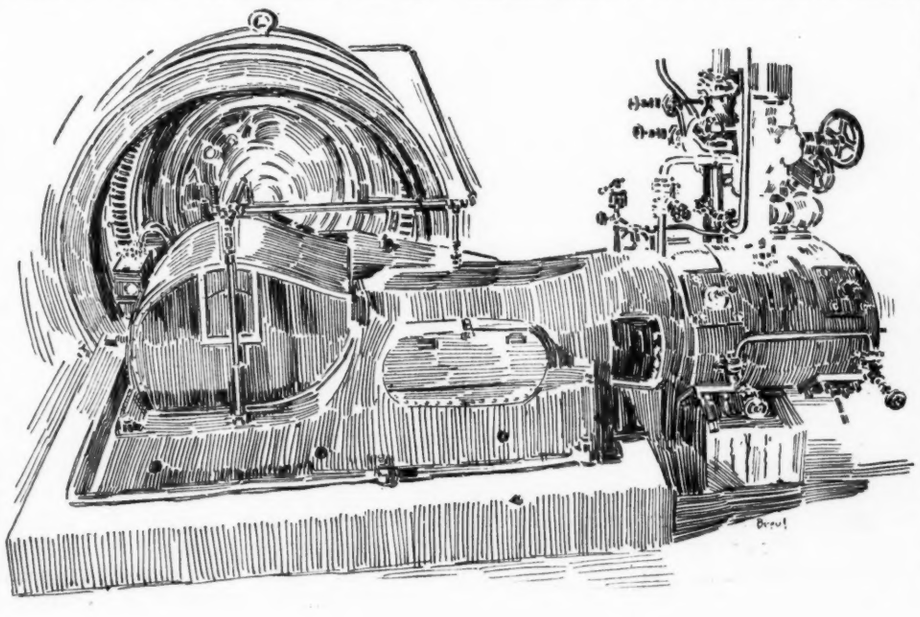
The load factor, both annual and weekly, has a big effect on the amount of current used per ton. A plant making 30,000 tons, with a good productive factor of 82½ per cent in ice, averaged 41.78 kw.-hr. for the year, and ran up to 48 kw.-hr. in July.

The figures given in the table are practical figures representing average good practice and are based on the pounds of ammonia that must be evaporated to produce a ton of refrigeration and the resulting cubic feet at the evaporator. To this is added the usual losses caused by cylinder heating, which "swells" the gas during compression. The figures can be and have been beaten by actual test by about 10 per cent, but is taken as an average good result in practical every-day operation. It is further assumed that the electricity paid for delivers 80 per cent of its power to the gas, or an allowance is made of 20 per cent for all losses in transmission and friction between the wire and the gas. It is then assumed that 65 per cent of the refrigerating power will manifest itself in ice made.

Some Loss Is Inevitable

Certain losses are inevitable, such as the cooling of the water (raw-water ice) from, say, 70 to 32 deg., also the loss by heat entering the ice tank, and the meltage from the can, and the heat to raise the ice from the tank temperature to 32 deg. These losses can be reduced only by a small percentage. So on the whole the figures cannot be beaten much over 10 per cent by the most expert and careful manipulation.

It is interesting to note the effect of increasing back pressure on the power costs. Only slightly better than the figures given in the table has been done under exceptional circumstances. These high results were obtained by experts in the (now classic) Eastman Kodak tests and are here given. In these tests the machine was turned up to its highest mechanical perfection. If, therefore, any plant owner is approximating the figures shown in the table, plus cost of operating auxiliaries at the pressures given, he is doing about the best he can do as to power and could not improve the efficiencies over 10 per cent at these pressures. Of course the head pressure may be higher than it ought to be by reason of air or "foul" gas or insufficient condenser surface, but that is another story. Often actual production is of more moment than production cost per ton. It may be better to produce 125 tons at a higher power cost per ton than 100 tons.



Above all it is necessary to remember that the power cost is but one portion, although an important one, of the entire cost to get the ice to the ultimate consumer or even to deliver it on the platform. The power cost is largely dependent on the back pressure available, for as far as power cost alone is concerned, it is better to manufacture at the highest back pressure, that is, the highest temperature, possible. Profit is dependent on the proper ratio being struck between the power cost and the salable production.

The clearance, as shown by cards, was practically negligible. The friction was reduced to a minimum, and the tests were conducted by such practical experts as Louis S. Moose, A. Winborg, Luther Bond, H. R. Fisher, R. T. Whitehouse, La Ramsay, William Stair, F. X. Kuhn and C. E. Allison on behalf of Yorke Co., and the reports were signed by Louis Block for the De La Vergne Co., A Winborg for the Yorke Co. and W. S. Lucey for the Eastman Co. The tests were witnessed also by such men as Dr. C. E. Lucke, Prof. E. D. Thurston, W. D. Monks and E. Dettmar in the De La Vergne interests, and Messrs. Cole, Lucey, Lindsay, Gapin and Tallinger, of the Eastman Company.

The final results of these tests at 185 gage head pressure and 20 gage back pressure were as follows:

Test No.	I. Hp. per Ton Refrigeration	Test No.	I. Hp. per Ton Refrigeration
1	1.418	4	1.422
2	1.427	5	1.425
3	1.389	6	1.439

Average of all, 1.42 hp. per ton refrigeration, or 26.42 kw.-hr per ton refrigeration or 39.01 kw.-hr. per ton of ice on a 65 per cent basis.

The table gives 44.1 kw.-hr. for ice for 185 and 20 lb. The test made by the best experts in America on a machine especially prepared for the test, therefore, showed only $\frac{44.1 - 39.01}{44.1} = 11.3$ per cent better than the table:

The best test result (No. 3) was 13.8 per cent better and the worst (No. 6) was 10.2 per cent better than the table. Hence under ordinary circumstances in the run of commercial work the results shown in the table should be considered satisfactory and can be beaten fractionally only with the utmost care, as the Eastman tests were very near the utmost possible theoretically.

Power Development in the Future

Effects Power Development in Its Various Forms Has Had Upon Industrial Progress —Limitations of Our Present Methods of Power Generation and Distribution— Central Stations and Isolated Plants—Superpower Plants and Recovery of Byproducts in Coal—Utilization of All the Products in Coal Imposes Itself in the Near Future

By LAZAROVICH-HREBELIANOVICH

THE labor of nature expressed in energy in all its forms of power has become today one of the most indispensable of marketable products, the parent of all production. The history of the progress of mankind all the way down to modern industry, is the story of the development of power, from the application to man's use of the crude forces, down to the gradual unlocking of the energy stored up in the world's making. Through the long ages, up to the very doors of modern life in the Eighteenth Century stretched the period of the primitive knowledge and use of power. This period, the period of wind and water, is marked by the limited, local and individual character of its industries.

The Industrial Revolution

When men began to liberate the energy of coal and use the power of steam as a motive force, the old world order passed away and the so-called "industrial revolution," a hundred years ago, ushered in the formative period of modern industry and of the new world order now dawning. The use of steam freed power from geographic restrictions inherent in hydraulic power, opened the coal fields and the oil wells and created and developed transportation and industry as they are today.

Present industry has been developed on the basis of the distributive use of coal. Although the possible expansion of industry is unlimited, the means of bringing to it energy in the form of coal, requiring a relatively enormous and superfluous bulk, has well-nigh reached the limit of transportation capacity. Since not over 20 per cent of the energy contained in coal is made available from the fuel under the boilers in the most favorable conditions, a more complete utilization of coal has become imperative. This situation signals practically the end of the formative period of industry, and the opening of the reign of the new motive force, "electricity."

Electricity, virtually energy itself, is free from substantial form, devoid of bulk, practically abolishing time in its transmission, and to a great extent distance, capable of subdivision and distribution, easy of application and adaptable to a vast range of utilization. All these capacities and characteristics make it possible to measure, buy, sell, distribute and use energy, whereby power is a marketable product. With the coming in of this new article of commerce, human industry in all its branches enters the era of unlimited possibility.

Development of Central Power Stations

The following figures, covering the development of central power stations in the United States, show the rapid increase in the use of electric energy in the form of power and light: Electric energy generated for sale in 1907 was 10,621,407,000 kw.-hr.; 1912, 17,585,622,000 kw.-hr.; 1917, 27,000,000,000 kw.-hr.; and in 1920 it will be over 40,000,000,000 kw.-hr., which shows an increase of around 300 per cent over the production that was obtained in 1907.

Electric energy is generated either by water power or by the use of coal or oil. At present the hydro-electric power production is equal to the use of about 40,000,000 tons of coal, whereas over 400,000,000 tons, or two-thirds of the total coal production in the United States is yearly consumed to produce steam and electric power.

The total water power developed at present in the United States amounts to about 9,823,000 hp. (Water Power Committee with Electric Light Association), of which about 4,500,000 hp. is commercial power. The potential water power is estimated at about 200,000,000 hp., of which about 20,000,000 hp. is capable of immediate development. Of the aforementioned total potential water power 60,000,000 hp. could be used without special provisions for storage. About 13 per cent (report National Electric Light Association) of the readily available water power and 3 per cent of the total open to development under arrangements for water storage have been developed.

Approximately 600,000,000 tons of coal is required annually in the United States, and the mines can furnish about 750,000,000 tons per annum, but the railroads are unable to handle normally more than 550,000,000 tons, the failure of the roads to do so being attributable to lack of motive power, car shortage and delay in unloading.

Transportation Facilities Required to Handle Coal for Power

It has been said in the foregoing that the power production in this country—steam and electric power together—consumes about 400,000,000 tons per annum, the moving of which requires about 10,000,000 carloads, at 40-ton car capacity. In 1917 there were in the United States 950,000 coal cars in use. In addition there has also to be moved about 160,000,000 tons of coal for heating and coke-making purposes, the transportation of which requires another 4,000,000 carloads. Thus the total annual hauling requirement for coal is 14,000,000 carloads.

Let it be assumed that the water power at present not utilized but economically immediately available for the generation of electric power amounts to 20,000,000 electric horsepower. On an average it requires about 15 tons of coal to generate one electrical horsepower year, hence these 20,000,000 hp. of water power represent about 300,000,000 tons of coal, which by the utilization of that water power could be saved, relieving thereby the means of transportation, which would then not be taxed above their capacity.

In spite of the growing use of electricity practically no change has been effected in the method of using coal.

and only a small fraction of the available water power has been developed, although electricity has rehabilitated the use of water power, making available for generating purposes the two main sources of energy; namely, fuel and water.

Central Station Versus Isolated Plant—Three Possible Solutions

In the United States for over twenty years a controversy has been going on between the advocates of central stations and those of private or isolated plants, as the most economical means of power supply. The respective merits of each of these systems have been put forward, certain salient points being acknowledged by both sides. The central-station or public-utility field includes a host of establishments where the installation of isloated plants is not warranted, as also the isolated plant is an economic necessity in certain types of buildings and in certain manufacturing establishments in which heat and process steam are of prime necessity.

This situation caused a third school to come forward and to advocate as a solution of the problem the making available of the commodity by a co-operation of central stations with isolated plants. To this school must be added the plan of a further utilization of the fuel by developing a central-station service of heat and steam, which service in concurrence with gas and electric current is in practice in some cities.

However, the advocates of central-station supply and those of private isolated plants, and those who would find a solution of the problem in a co-operation of these two supply methods, as well as those who propose further utilization of fuel by a central-station service of steam and heat, concern themselves only with coal, oil or gas as direct fuel, forgetting that at best only about 20 per cent and frequently only about 6 per cent of the energy content of coal is transformed into the marketable product, power.

Superpower Plants and Multiple Production of Power and Byproducts from Coal

The use of electric power today is a product of such increasing demand that the issue is of a general power problem and not one of hydro-electric power or steam-electric power, or of central stations or isolated plants. Transmission lines 100 miles in length are common today and lines 200 and 300 miles long are in use, hence power can be transmitted long distances and the question is whether it be more advantageous to transport generated power or to transport energy in bulk; that is, fuel to generate the power. This question in itself indicates that the basis of the problem is economy in material and human effort, which requires the fullest utilization of the sources of energy.

Coal, besides being energy in material and bulky form, is also the source of innumerable products of great economic value. More than one thousand coal products, as vital to the community as fuel, are today in use. The full utilization of the whole range of values, including energy, today still transported in the form of coal, imposes itself in the near future. This utilization, at present confined to the coke and gas industry, which can still be described by the term of "byproduct production" as it takes only half the field, must broaden itself and become an economic force covered by the term of "multiple production." There lies the future and the only great future for what we call the "gas industry."

The meaning of "multiple production" becomes apparent when it is remembered that one ton of bituminous coal gives 10,000 cu.ft. of illuminating (or fuel) gas, 20 lb. of ammonium sulphate, 2½ gal. of benzol and 8⅓ gal. of tar, which represent only the primary products; while other chemicals, drugs, dyestuffs, etc., could be extracted. The illuminating gas and the benzol are, one a perfect fuel and the other an equivalent of gasoline as motor fuel. Multiple production will make both gas and benzol important sources for power generation.

Enormous Waste of Coal Due to Poor Boiler-Room Practice

It has been estimated by the Fuel Administration that between 10 and 25 per cent of steam coal is at present wasted when burned under the boilers, caused by poor boiler-room practice. About 420,000,000 tons of the annual requirements of hard and soft coal in the United States is used to generate power, half of which is used by industry and the other half is consumed by the transportation lines. Reckoning on the basis of a 12 per cent avoidable wastage gives a minimum annual wastage of 50,000,000 tons of steam coal.

Although electric power generation and transmission has made headway, multiple power production is yet to be generally adopted, its importance not yet having been grasped. Yet both are the most important economic forces of molding influence on the present industrial order. The principle of multiple power production as an economic force is bound to cause a revision in popularly accepted ideas of economics.

British Coal Conservation Plan Recommended by Reconstruction Committee

Numerous plans are advocated representing solutions of the industrial-power problem. The most radical solution, involving the principle of multiple power production, is perhaps the plan advocated by the British Coal-Conservation Committee, of which the following is an abstract:

The subcommittee of the Reconstruction Committee in Great Britain recommends that the present inefficient electric-service system should be superseded by a comprehensive system divided into about sixteen districts in each of which there should be one authority dealing with all generation and main distribution. Sites for electric generating purposes should be chosen on important waterways outside, not inside of towns. Plans to be prepared to construct on these sites large superpower plants, capable (1) of supplying energy to a comprehensive electric power-distribution system; (2) of supplying electric energy at lowest possible price for all processes and manufacture. Such plants should be designed so that, as methods are perfected for extracting byproducts from fuel before using it for the purpose of production of electrical energy, the byproduct plant can be combined with the power plant. Power available from surplus gas or waste heat should be turned into electrical energy in local plants, which should feed into the main distributing system. Coal which does not warrant transportation away from the mine should be used at the spot for power generation. With a view to carrying out this policy a board of commissioners should be appointed with the following powers: (a) to stop the extension or multiplication of uneconomical stations for public supply; (b) to arrange for the handing over on equitable terms of the generation, transmission and main distributing system in each of the areas into which the country is to be divided; (c) to standardize for each area the frequency and voltage of the main transmission and distribution systems; (d) to select for each area the authori-

ties to work under adequate control as regards limitation of dividends, etc.

Alternative types of electric organizations are described in an appendix. In reference to these alternative types the subcommittee emphasizes the need of initiative and resource in management of electric service organizations and the freedom of range and keenness which are distinctive of private enterprise, as such things are highly conducive to the best success. Here is a superpower central station plan based on coal as source of energy combined with the application of the principle of multiple production.

In the United States and elsewhere all plans which follow the idea of superpower stations and of multple production, take into account the necessary development of available water power as the source of energy for those regions lacking coal. The British superpower station plan and those following that idea offer the sole solution taking into consideration the principle of multiple production and with it the replacement of steam as power by internal-combustion (gas or benzol) engines and electric energy.

The Sale of Electric Power

Electric plants were first established to furnish current for lighting. The operating costs and the profits of the enterprise were borne by these consumers. Soon it was found that the plant could be operated cheaply during the daytime, provided the light consumers continued to bear the burden of the operating costs, the sale of power generated during the day representing net gain. This was the starting point of the methods of selling electric power. With the increased use of electric light and power and electric energy becoming a salable product, innumerable systems of determining a just and logical rate charge were put forward and came into use.

In accord with the general tendency toward standardization and simplification, certain simplified tariff systems have in late years been proposed, systems that are said to be suitable in any area of supply and whose principle is the abolishing of the "diversity factor" as well as the "load factor." The most characteristic of these suggested systems is the so-called "postal plan" of selling power to industry and any other consumer of electric energy.

Postal Principle of Selling Power

The postal principle of selling means a fixed charge per kilowatt-hour independent of maximum demand and number of customers served, taking only into account the number of kilowatt-hours sold, the plan being based on the idea that a two-cent stamp will carry a letter anywhere—the two cents representing the sale price of the postal service for a given unit of weight of letter. If the average cost of generating electric energy is two cents per kilowatt-hour, a uniform rate per kilowatt-hour could be established, say a two-cent rate, independent of class of service, lighting, power or traction load and independent of the quantity of service that is required.

The question is whether such a plan is feasible with conditions as they are at present in the central-power-station industry. Today what mostly handicaps its development, whether the power is produced from coal or waterfalls, is the necessity of providing means of transmission and distribution, which require a great initial investment with high costs of maintenance.

The postal service is that of a common carrier of the public utility order, and in applying to the selling of energy the principle of selling service for a given unit of weight for a fixed standard price, we will have to adopt the common public-carrier system for the transmission of electric energy. The British superpower-station plan recognizes that necessity and provides for the standardization of frequency and voltage of the main transmission and distributing systems and for an authority to deal with generation and distribution. A universal standard tariff system, like the postal plan of selling energy, would certainly have an enormous influence on industry and give a tremendous impetus to the use of electric energy. Power would then really become a salable product, cheap, staple and of even more general use than at present.

Co-ordination of Interests Urged

The prime function of industry is service to the community, to be rewarded commensurately with that service. Power is the basis of industry; without it industry cannot exist. Hence, power is a force of prime necessity to the welfare of the community and should be dealt with in that sense. The criterion in the generation and sale of power, therefore, should not be primarily or exclusively the stockholders' profits in that specific enterprise, but should have regard to the interests which the country and community at large have in the generation and sale of power; that is, in the availability of cheap and unlimited power—a co-ordination of the interests of the community and of capital.

It must not be forgotten that the world order around us, especially in is economic bearings and the position of industry, has not yet fully emerged from the formative period ushered in one hundred years ago by the so-called "industrial revolution." Present-day economic procedure is still mainly the product of a period when the nature of energy resources was only imperfectly known and the technology of the employment of energy only crudely developed.

In the old and still lingering order men worked with the idea that the resoures of nature were inexhaustible, and their undeveloped methods and conditions were inadequate and impotent, unable to avoid large wastes, which are not only inexcusable with the modern means at hand, but which are responsible to society, being directly connected with economic and social questions at the base of general well being.

Avoidable Waste and Loss

There is still lack of the application of improved methods in the mining of coal, and the production of oil, both cases causing avoidable waste and loss, the consequences of which are more serious in regard to oil—the ultimate exhaustion of it is in view—than concerning coal, which is still abundant. Only a fraction of the hydro-electric resources capable of replacing coal and oil is developed.

The anomaly of the situation is seen of coal being hauled across the whole continent to move trains across the Rocky Mountain Divide, where ample hydro-electric power is close at hand. The transportation of coal means waste of effort and material. The present utilization of coal allows only a very low recovery of its energy content, in addition to which one-quarter more coal, on an average, is burned in power production than is neces-

sary. The utilization of oil is efficient only in the refined products, but most wasteful in the crude as it is utilized in many cases at present.

Wastefulness in production in any branch of industry is not necessarily considered an evil, but rather as an asset to profit. It is found that the public can be relied upon to pay any price as long as the production cost is high enough to prevent the profits from appearing extortionate. The expense of waste in industrial production is passed over to the consumer. Prices are maintained by the willful reduction of production, which is kept below the level of demand. The majority of industries use only half of their equipment, or otherwise stated, work half-time. There is lack of co-ordination, lack of proper media of distribution, with the result that commodities are burdened with costs that are far in excess of the costs of production. To sell the product costs more today than to produce it—obviously this is not economically correct.

The waste of labor and material, the inadequacy of distribution and the inelasticity of credit form a group of causes intimately connected and mutually reactive upon one another, making impossible the attainment of 100 per cent production either from industry or the utilization of the soil. The result is directly due to the lack of co-ordination between resources, technology and economic procedure.

In the realm of advance preparation free operation and full individualistic endeavor are desirable, as competition has proved itself an effective means of progress and development at that stage. In the realm of full utilization competition fails to give adequate results, and its effect is rather harmful and must give way to constructive mutual consideration and co-ordination in the interest of the community as a whole.

A New World Order Dawning

The "industrial revolution," which brought in the formative period now passing away, was in close interrelation with a general world upheaval. Today the world again is in travail, out of which will arise a new world order, economic, political and social, in which coordination of all human activity toward economy of material and human effort will be the fundamental basic principle.

The "formative period" has been the age of coal as fuel and steam as power. The new time is already outlined as the era of coal fully utilized and water as sources of energy, and electricity as power.

The inherently local nature of the generation and use of steam power prevented it from ever becoming a salable product. The contrary is true in regard to electric power. The characteristics of electric power constituting it a true article of commerce, the fact that it can be generated in bulk and sold at retail, the ease and flexibility of its transmission to a distance from its point of generation by means which can be extended at will, make natural the centralization of its generation. That centralization makes possible industrial efficiency with economy in material and human effort which is becoming more and more a necessity.

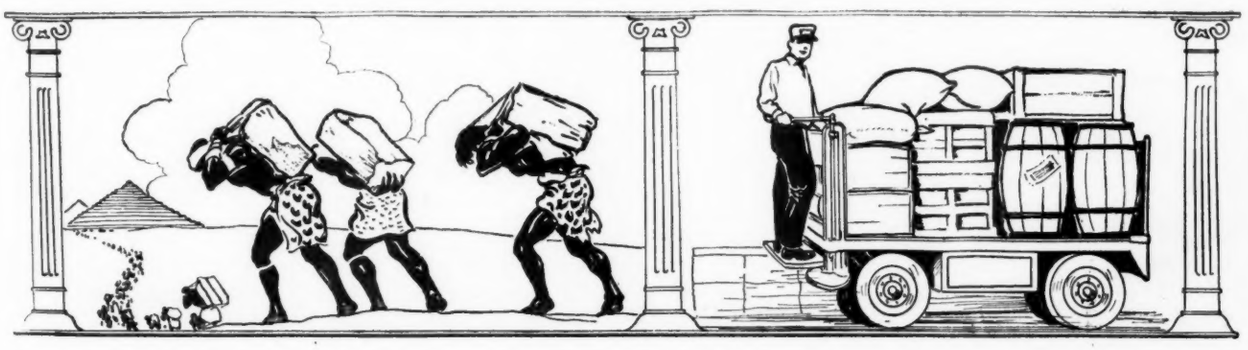
These results are attainable only through co-ordination of resources, technology and economic procedure, necessitating a co-operative organization of the whole industry of power production, for the efficient employment of energy sources, their production and full utilization—multiple production—the generation of energy, its transmission and distribution, on the principle of service to the community.

Vital Question in Power Production and Distribution

The vital question is whether such an organization so based on the principle of the general good, is to come into being, or whether the power industry, which is already in the hands of large amalgamated interests, shall become more and more centralized in those hands until it constitutes an absolute monopoly upon which the entire industrial and other power requirements of the country will depend. An alternative, urged by some, would provide for the public control of the sources of energy, its production, generation, transmission and distribution.

Whether the control, private or public, should take the form of an organization covering superpower stations, combined with byproduct plants and transmission and distribution systems, following the plan outlined by the Hon. F. K. Lane when he was Secretary of the Interior, or whether the result should be obtained by means of co-operation between central power stations, isolated plants, coke and gas plants, and a separately organized power transmission and distribution system, whether the management of the power production, fuel-utilization plants and power-transmission and distribution systems should be in the hand of the state or in the hand of semi-public, state-financed, public-utilities corporations, or should be left to private corporations under public supervision—these are questions beyond the scope of the present discussion and will be left for future consideration.

However, one thing is clear—in the new economic world order now arising, the principle of electricity as a marketable product, the principle of common public carrier applied to the transmission of power and the principle of multiple production for the utilization of energy sources will be the most important, if not the basic, economic force in the industrial order and in the life of the people itself.



Selection of Babbitt Metal

By L. D. STAPLIN
Manager, Merit Metal Department, Great Western Smelting and Refining Company, Chicago

TWO phases of the bearing-metal question that are of prime importance to the user are: First, selection of the grade giving the highest efficiency, meaning greatest durability at least cost; second, proper application. The application is more important than is the grade itself, but since the metal must be selected before it can be applied this article will give information that may help in the choice and use of the right kind of metal.

A babbitt metal must possess sufficient "body" or structure to carry the load upon the bearing with a margin of safety; otherwise, rebabbitting and delays will result. As tin and copper are added to a babbitt base the structure of the material is made harder and generally tougher. Since these metals are the most costly ingredients it is folly to use an alloy containing more of them than the bearing necessitates, since nothing but compression strength is gained from their presence.

Many are of the opinion that antimony should be the chief hardening agent in bearing metals. This may be true if the metal is to be used only where the load carried is constant or light and the speed low. Experience has proved that a babbitt metal must contain a material quantity of tin (and it should also carry copper) if it is to be used generally on machinery bearings, because only then does the alloy possess the required "body." Without these ingredients the metal is so soft that it crushes beneath the load and wears out quickly.

Silver is a better conductor of electricity than copper, but copper is used because it is good enough and costs less. Mr. Staplin applies the same principle to babbitt metal, and explains how to select the cheapest babbitt that will do the work. In a later article he will take up the application of babbitt, including the design of bearings and the saving of metal.

In some cases efforts have been made to increase the percentage of antimony and in that way make the metal hard enough to carry average heavy loads at high speeds; but although antimony is a positive hardener, these attempts have not succeeded for the reason that such alloys are extremely brittle. If cast when overheated the grain is coarse and in "packing" beneath heavy or even moderate pressures clearance is created. This action has the same effect upon the life of the bearing as though the natural wear had reduced the thickness of the liner just that much. The writer, therefore, does not consider alloys of lead and antimony alone nor alloys of lead, arsenic and antimony as good babbitt metals for general purposes, as they have not given suitable or safe service when used upon any but light work.

Since the user gets hardness and toughness through the addition of tin and copper, and since these ingredients are costly and nothing is gained when they are used to excess, it follows that the careful and progressive consumer should know how to judge his selection of babbitt metals, so that he will not be wasting money by purchasing material more costly than necessary for the particular purpose for which it is to be used If a ten-pound sledge is laid gently upon a glass desk top nothing will happen; but if the sledge is lifted an inch and then let drop the glass will be shattered. So it is with bearings and bearings metals, and the point to determine is the nature of the service. During its operation, is the bearing subjected to jars, jolts, sudden loads and shocks or extreme strains, or is the load that is carried even and constant? If the service is of the latter variety it is safe to use babbitt metal of inexpensive grade. The tin and copper contents should be increased with the severity of the service. The character of the service, therefore, is to be considered first and foremost when deciding upon the alloy to use for any specific kind of bearing.

When machinery is exposed to dust, as in cement and clay working, the dust acts as an abrasive and destroys the liners. Durability depends upon the hardness and density of the lining metal and is increased in ratio with the amount of tin and copper carried. Reliable tests that may be used for guidance have confirmed the foregoing contention. Considering babbitt metals to be used by a builder of machinery, selection of bearing alloys possessing ample margins of safety under actual operating conditions should be based on exhaustive tests rather than on theory and imagination. Only then will the manufacturer know definitely that he is delivering to his trade value received.

With babbitt metals to be used by an industrial concern for repairs to machinery best results are had when the selection of babbitt is limited to two grades—one lead-based and one tin-based. Discretion is necessary in choosing their proper places, and care must be used in their application.

In general, there are two classes of bearing metal—tin-based and lead-based. First-quality tin-based babbitts cost about double the price asked for lead-based metal of the first quality. As a rule bearing conditions in the plant machinery vary, and it is not uncommon for 20 per cent of the total bearings to need tin-based metals, while the remainder can be durably and more economically served with a lead-based metal of good grade.

When there is a wide range in bearing needs it becomes necessary in working with two grades only to use at times a metal that is actually better than required for a particular bearing, but, notwithstanding, it has been found preferable in the average plant to use two rather than five or six different kinds of metals, to eliminate confusion. Getting down to two established standardized grades and then intelligently listing the equipment's needs has worked out most satisfactorily in practice.

In selecting these two grades, the writer's choice would be a tin-based material of the finest quality containing fully 89 per cent of "Straits" tin and no lead and a lead-based metal containing not less than 10

per cent of tin and between ½ of 1 per cent and 1 per cent of copper, with not more than 16 per cent of antimony.

The word "tin" does not mean much in a specification. There never was a babbitt specification which could not be so beaten by the maker (if he desired) as to reduce the material's service value far out of proportion to the saving effected by buying the cheapest bid material. There are many grades of tin and they vary in cost. Some grades depreciate the service value of the babbitt. "Straits tin" are two safe words to use in the specification. And even then, how many are there who can tell afterward whether or not the material was made of Straits or No. 3 Chinese tin? The buyer depends upon either the veracity and standing of the maker or upon his own laboratory.

A laboratory analysis is not a safe basis for judging the relative value from a service viewpoint of two babbitt metals. It will tell the percentages of ingredients, but will not give details of workmanship and service value. Therefore, when buying babbitts for service where the conditions are extreme and where something a little better is worth more than a small difference in price, it is economy for the buyer to use judgment as well as quotations as his guide toward a good selection. The final and deciding data are, of course, results in service.

When selecting babbitt metals for installation in important bearings, where the production from that machinery creates the firm's profits, a purchasing agent makes the wrong move when he puts that business upon a competitive basis and thus invites bids so low that the makers have a temptation to skimp. Instead, he would do better to select the highest-grade branded metal, in which the manufacturer is interested in maintaining a rigid standard and standing, as it is known that only service value can build for a lasting demand. Such metal can be had within a few cents per pound of what is asked for specification metal. It is the better choice.

Were the author a consumer of babbitt metals it would be his policy to place his conditions squarely before a dependable metal manufacturer and then leave the selection largely to him. If he has integrity and the ability to furnish good metal, the confidence will not be misplaced. Results from practice will show that the honest specialist is able to make the better selection of metal.

Storage of Coal

By W. D. LANGTRY*

In this article, which is the fourth on the storage of coal, Mr. Langtry deals with several factors which lead to coal fires.

For coal to catch on fire after it is in storage means a money loss to the owner of greater magnitude than ever before, so that every precaution should be taken.

TABLE I—LOSS IN HEAT VALUE OF COAL FROM STORAGE

Coal Stored during 1918:		Same coal stored 2 yr.:	
Dry ash	14.33	Dry ash	14.17
Dry B.t.u.	12,393	Dry B.t.u.	11,668
Average of 472 cars:		Same coal stored 1 yr.	
Dry ash	14.33	Dry ash	14.52
Dry B.t.u.	12,393	Dry B.t.u.	12,200

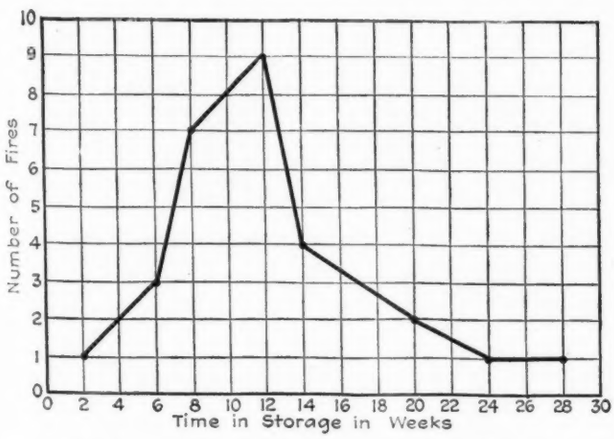


FIG. 1. STORAGE GRAPH SHOWING FIRES AT DIFFERENT INTERVALS

There is no great loss in the heat value of the coal when it is in open storage, and when under water the loss is negligible. In Table I the analysis of fresh coal and that placed in storage may be of interest. The depth of this coal in storage was about 7 to 8 ft. Table II, taken from Bulletin No. 116, Illinois Engineering Experiment Station, also shows slight deterioration.

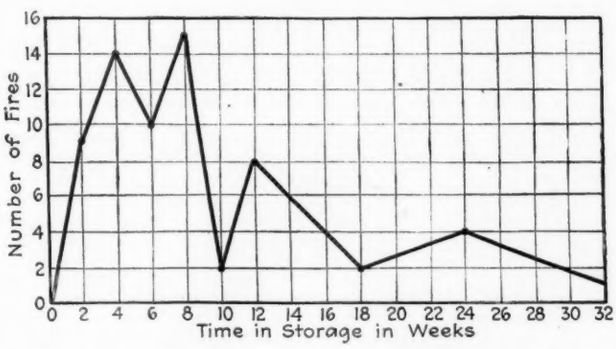


FIG. 2. NUMBER OF FIRES VS. WEEKS OF STORAGE

The coal in storage 18 months was piled 10 or 12 ft. high and the pile was about 150 ft. long and 25 ft. wide, bulkhead with wooden anchors running into the pile.

TABLE II—DETERIORATION OF COAL IN STORAGE

	Coal from Boiler Room (or Fresh Coal) Per Cent Commercial	Coal in Storage 4 mo. Per Cent Commercial	Coal in Storage 18mo. Per Cent Commercial
Moisture	10.25	12.44	11.89
Ash	9.08	9.16	7.98
Volatile	33.18	33.12	33.28
Fixed Carbon	47.49	45.28	46.85
B.t.u. (moisture ash and sulphur free)	14,816	14,761	4,713

It was reported that the temperature was at no time more than a few degrees over 100 deg. F.

Usually the greatest number of fires take place during the first ninety days of storage. By this time much of the coal that catches on fire from spontaneous

*President, Commercial Testing and Engineering Co., Chicago.

combustion will have shown evidences of overheating. The accompanying two graphs from Bulletin No. 116, which were plotted from a wide range of data, tend to confirm this assertion. A fire in a coal pile is usually detected long before it gets to the serious stages. Probably by studying some of the views presented deductions may be drawn as to the causes of trouble and how to avoid them.

Fig. 3 shows a large coal yard which fired. No attention whatever had been given to the manner of piling the coal, nor to the presence of wooden timbers, which in some instances were completely buried. It is easy to see how air could follow the wood to the inside of the pile where it found a susceptible spot to work upon. Fig. 4, from the same yard, shows very clearly the timbers buried in the coal. In Fig. 5 a pile is shown where a number of boards were allowed to remain at the bottom of the pile. The protruding ends of these boards afforded easy access to the air. Heat transmission is shown in Figs. 6 and 7 the former being from a furnace in a flat building and the latter from a hot water tank. It is seldom that lump coal catches on fire from spontaneous combustion, for the reason that usually there is no fine coal to give it a start, but when a neighboring pile of screenings fires and spreads its hot gases, even lump coal will ignite.

When placed adjacent to coal, a steam pipe trench is a dangerous heating agent, as is evident from Fig. 8. Here the heat from the steam pipes ignited the coal dust which had settled into the trench. The fire spread to the adjoining pile.

To dig down into a coal pile to locate a fire and find a buried bulkhead is nothing unusual. This is a frequent occurrence and a contributing factor in a large number of fires.

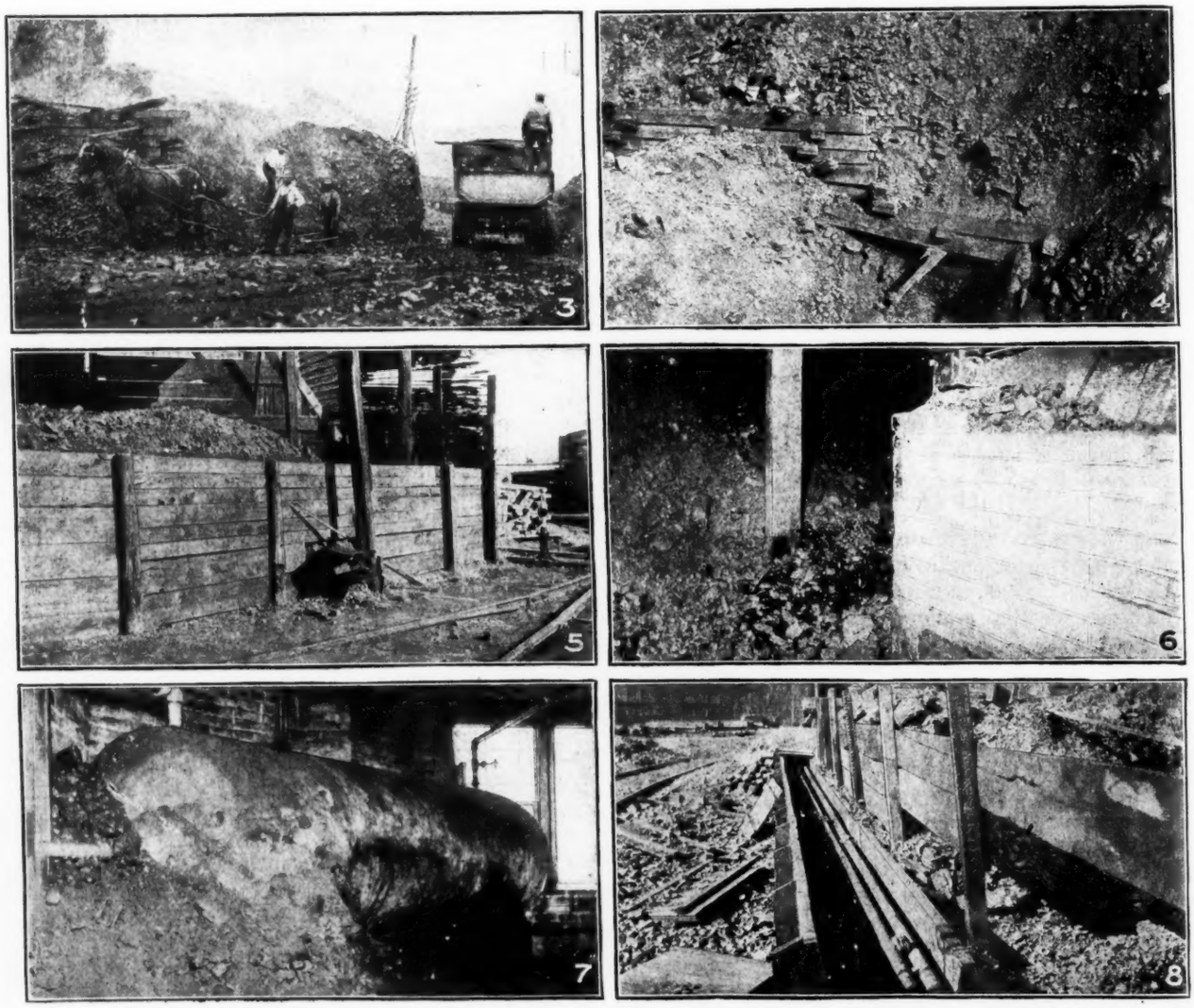


FIG. 3. ENTIRE COAL YARD ON FIRE. FIG. 4. EMBEDDED TIMBERS THAT STARTED FIRE IN FIG. 3. FIG. 5. PLANKS EMBEDDED UNDER COAL ADMITTING AIR TO INTERIOR OF PILE. FIG. 6. HOT FURNACE WALL STARTED FIRE IN BASEMENT OF FLAT BUILDING. FIG. 7. EMBEDDED HOT-WATER TANK ORIGINATED FIRE. FIG. 8. STEAM PIPES STARTED FIRE IN COAL

And so it goes. Carelessness, thoughtlessness and ignorance—all contribute to spontaneous combustion. Coal is blamed, whereas in many instances the fault really lies elsewhere. If proper care and thought had been given to storage, each and every one of these fires might have been avoided. Coal can be stored successfully if done intelligently.

Timing Relays With a Cycle Counter

To Time Protective Relays Automatically Is the Function of the Cycle Counter—Construction and Operation Explained—Problems Worked Out To Show the Application to Making Tests

BY VICTOR H. TODD

BEFORE the introduction of the cycle counter the generally approved method of determining the time delay of a protective relay was to use a stop watch, starting the watch simultaneously with the application of overload and stopping it at the instant of tripping. With the older relays, having a time delay of several seconds, this method gave satisfactory results, but with the more modern relays, designed with watt-hour meter accuracy and capable of being set within a fraction of a second, it is obvious that the stop-watch method is not at all suitable.

A stop watch at best cannot be relied upon closer than about one-fifth of a second, and when to this is added the personal error of starting and stopping, it gives a possible error almost as great as the time between various sectionalizing relays. It is not at all unusual to set sectionalizing relays in a radial system only one-half second apart.

To measure the time delay of a protective relay accurately and automatically is the function of the cycle counter. This instrument is shown in Fig. 1, while two interior views are shown in Figs. 2 and 3. The cycle counter consists essentially of a self-winding clock in which the escapement wheel or pendulum is replaced by a polarized relay. The diagrammatic scheme of parts is shown in Fig. 4. The regular escapement wheel is shown at *W*. Attached to this wheel is the indicating pointer moving over a suitable scale, Fig. 1. The escapement bar *B* allows the wheel *W* to move one tooth per oscillation in the regular manner. Rigidly attached to the bar *B* is an iron armature *A*, polarized by the permanent magnets *D* and *D*. Part of the magnetic circuit is formed by the two electromagnets *E* and *E*, which are capable of attracting and repelling opposite ends of the armature *A*. The action is as follows:

Assume that during the first cycle of applied voltage, the current flows from the ± to the ∓ terminal. This will produce an N pole on the armature end of the right-hand electromagnet and an S pole on the corresponding end of the left-hand electromagnet. As both ends of the armature *A* are polarized *N*, the right-hand end will be repelled and the left-hand end attracted. During the second half of the cycle the current is reversed, and now the right-hand end is attracted and the left-hand end repelled, which naturally results in one oscillation of the bar *B* and the escapement of one tooth. From this it will readily be seen that the wheel moves one tooth per cycle as long as the electromagnets are energized. A small electric motor automatically rewinds the main clock spring, when it has unwound a certain amount. This keeps an even tension on the escapement and the electromagnets are thus not depended on to drive the mechanism, but simply to regulate its speed. Determining the time delay now becomes a problem of energizing the electromagnets simultaneously with the application of load and de-energizing them upon the instant of tripping. This is most easily done by

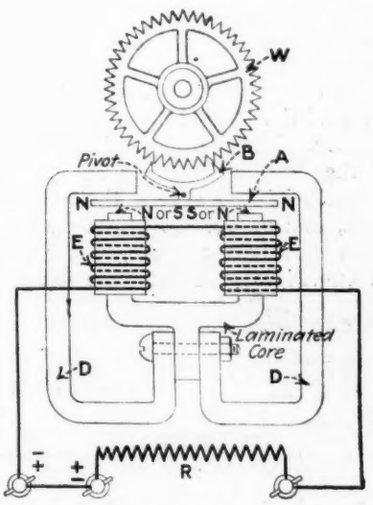
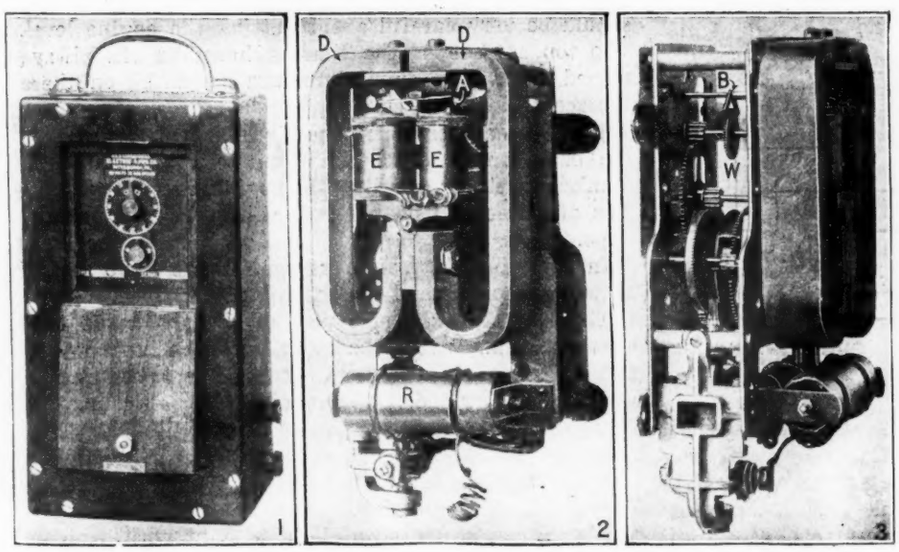


FIG. 4. SCHEMATIC DIAGRAM OF CYCLE COUNTER



FIGS. 1 TO 3. EXTERIOR AND INTERIOR VIEWS OF CYCLE COUNTER

temporarily disconnecting the relay from the circuit and connecting to a test circuit with connections as shown in Fig. 5, using a lamp bank or other suitable resistance for the load and a switch by which this load may be quickly applied. While adjusting the load, it is best to disconnect the lead at *A*, to avoid unnecessary wear on the counter. A single-pole switch may be provided for this purpose, as shown. After adjusting the load, the main testing switch is opened, the relay allowed to fully reset, and the cycle-counter pointers set on zero. Then the switch is closed, thus applying load and potential to the relay and counter. The counter revolves, one tooth per cycle, until the relay contacts close, when they short-circuit the escapement electromagnets and thus stop the counter instantly.

The number of cycles indicated, divided by the normal frequency of the testing circuit, will give the time delay in seconds. For instance, if used on a 25-cycle circuit and the counter indicates 50 cycles, the time will be 2 seconds; if 30 cycles, then the time would be 1½ seconds, and so on. It is common practice not to reduce the cycles to seconds, but on the testing reports and curves to give the time delay directly in

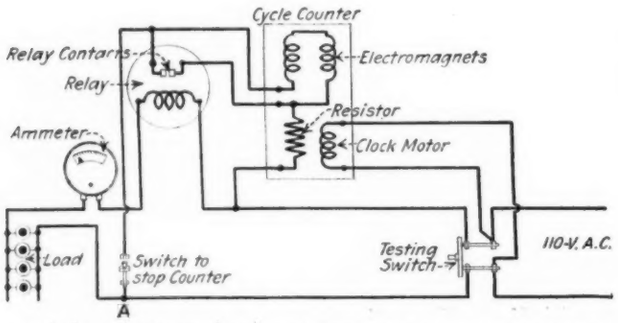


FIG. 5. CONNECTIONS FOR TESTING CIRCUIT-CLOSING RELAY WITH CYCLE COUNTER

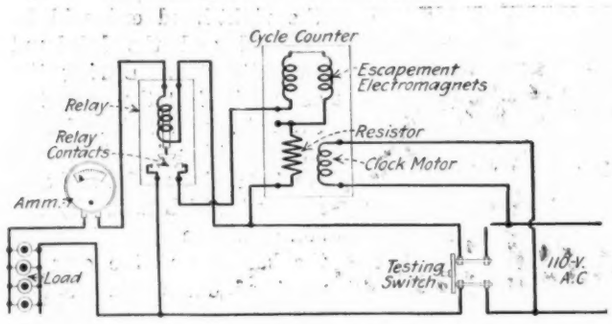


FIG. 6. CONNECTIONS FOR TESTING CIRCUIT-OPENING RELAY WITH CYCLE COUNTER

cycles, thus giving units that are more easily handled than fractions of a second.

In determining the time delay of a circuit-opening relay, it is simply necessary to connect the escapement solenoids in series with the relay contacts, as shown in Fig. 6. Closing the main testing switch energizes both the relay and counter simultaneously, and the counter stops the instant the contacts open.

To make allowance for the time taken by the breaker or oil switch and its auxiliary equipment to open the circuit, it is sometimes preferable, in a closely set system, to time the whole combination as a unit. To do this, a load must be arranged so that it can be quickly thrown directly on the line, with connections similar to those indicated in Fig. 7. The counter is connected to the load side of the switch. It is energized at the same instant that the load is applied and is de-energized the instant the breaker or switch opens.

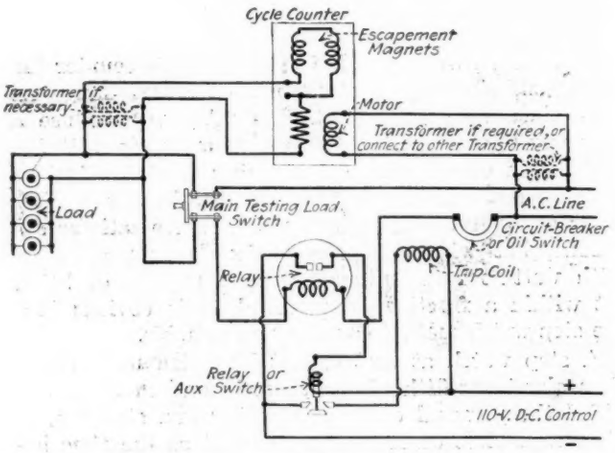


FIG. 7. CONNECTIONS FOR TESTING COMPLETE CIRCUIT-OPENING EQUIPMENT

This not only gives the time delay between instant of overload and opening of circuit, accurately and automatically, but also insures that all protective apparatus is functioning properly.

Semi-Diesel and Hot-Bulb Engine Suggestions

When installing an oil engine, have a foundation of sufficient size. Many engines are damaged from severe vibrations which would be eliminated by using more foundation material.

In placing the engine on the foundation, the engineer should be very careful about getting the engine level. The top surface of the bearing housings are always planed true. The spirit level can be placed on these surfaces.

In those engines where the air is drawn from under the base cement dust will often be drawn into the crankcase. After grouting the engine, a couple of gallons of linseed oil poured under the base will prevent cement dust.

In adjusting the main bearings, always leave a play between the shaft and top bearing of 0.01 inch.

There is always a side play of the shaft. If this exceeds $\frac{3}{32}$ in., it must be taken up. The best way is to put in new air-seal rings between the crank throws and the bearing ends. If new air-seal rings cannot be secured, a thin brass sheet can be sweated onto the worn ring.

Never run the crankpin bearing as snug as with a Diesel. A clearance of 0.01 inch is not excessive. If the brass can be moved a slight amount with a pinch bar, the play is ample. Examine the crankpin bearing bolts often. There are many cases of broken crankcases and pistons resulting from neglect of the bolts.

Never let lubricating oil collect in the crankcase. It mixes with the crankcase air and enters the cylinder, causing a smoky exhaust. If in large amounts, it will cause the engine to race since it will burn the same as fuel oil.

EDITORIALS

Power Development of the Future

ONE of the paramount problems in the minds of men today is the economical generation of power and the conservation of natural resources. Never before have these questions been so seriously considered, or such effort made toward their satisfactory solution. Almost every nation of any consequence has under advisement some power-generation scheme of national proportions. Even in those countries which have been most seriously handicapped by the war and which are today lacking the means to purchase sufficient food with, appropriations have been made to investigate the nation's power possibilities. Such countries as Norway, Sweden, Finland, Switzerland and Italy are considering the development of their water powers on an extensive national scale. England, who will always have to depend upon her coal fields as her chief source of power, is working out a system of districts to be supplied from superpower stations economically located in these districts. In our own country the tendencies are illustrated by the extensive interconnection of power systems until they now cover areas hundreds of miles in extent. The superpower schemes now projected for the North Atlantic seaboard and for the Pacific Coast are illustrative of what the future holds.

Before the war labor in Europe was cheap, consequently many of the processes done in this country by machinery were performed on the other side of the Atlantic by hand. But, during the war wages increased to such proportions that competition in the world's markets no longer can be met by pre-war methods, and countries that previously depended very largely upon hand labor in their industries are being forced to resort to mechanical processes. Where power-driven machinery was used on a large scale before the war, conditions have forced an even greater use of machinery, in other words a greater number of horsepower per employee. All this has resulted in giving an international importance to power development.

In this issue is published an article on "Power Development of the Future," by Lazarovich-Hrebelianovich, a well-known Czecho-Slovakian engineer and economist, who for a number of years has been interested in engineering and economic problems in this country. In this article the author has considered the problem from a national standpoint and shows that the development of power generation, formerly of interest only to the few, has become of vital importance to every individual in the community. Utilization of our national resources in the past has been done very largely on the basis that they were inexhaustible. But within recent years a realization that this is not true has been brought home to us by the fact that the exhaustion of two of our important sources of fuel is already in sight, with the prices of all fuels soaring to undreamed of heights, and even at these values very difficult to obtain in many cases. The fuel shortage and the inadequacy of transportation facilities have emphasized the necessity of an intelligent national power-development program, and the question now is what form this program shall take. Many different schemes have been advocated and are now under consideration. Mr. Hrebelianovich in his article emphasizes the necessity not only of water-power development, but also of a fuller utilization of our fuel, to the extent of obtaining the byproducts wasted by present methods. When it is considered that under the most favorable conditions, in power plants, only twenty per cent of the energy in the coal is utilized, the remainder being lost along with all the byproducts, the desirability of a more efficient method is obvious. The author has considered power production from a broad economic view and has pointed to many phases of vital interest to power engineers.

The Broader View

IN *Power* of October nineteenth a correspondent discusses Engineers' License Laws. His arguments are familiar; we have used them ourselves. License laws are passed for the general good of the public, not for the special good of the engineer. Any effect which they may have in improving the social and pecuniary condition of the members of the craft must be incidental to their operation for the public welfare. The only concern of the state is for the safety of its citizens. It has the right to protect them against danger from boiler explosions and other industrial accidents, but it has no right to insist upon the engineer's knowing any more than will qualify him from that point of view.

This is the older view. Public and legislative thought upon this subject has been through two phases and is entering upon a third and broader view.

When governmental supervision was proposed which would restrain users from putting in anything for a boiler that would hold water, running it at any pressure that they pleased and putting it in charge of a husky whose only qualification was the brute strength necessary to keep its furnace full of coal, alarmed proprietors put up a strenuous opposition. Such a measure was denounced as paternal, as an unwarranted interference with private enterprise. The employer saw in it a dangerous subterfuge on the part of working engineers and firemen to restrict the labor supply, the farmer and lumbermen were led to believe that they could not operate their threshing machines or portable sawmills without a licensed and uniformed attendant. Visions of overbearing and grafting inspectors, of boilers ordered out of service for non-compliance with trivial regulations were conjured up, and it was years before any considerable number of states or municipalities adopted any regulatory legislation.

The second phase came with the inevitable recognition of the economic importance of industrial accidents. Safe and hygienic conditions were impressed upon the owners and managers of industries by the establishment of industrial safety commissions, factory-inspection departments and employers' liability laws. Boiler-inspection departments have been established in many

of the states and provisions for examining and certifying the men in responsible charge of boilers and power-plant machinery in a few. No catastrophe and no general inconvenience to industry has resulted. The number of boiler explosions has without doubt been kept down by the better design, construction and operation insisted upon; how much, it is impossible even to estimate in the absence of statistics as to the number and character of boilers in use. When all the states have boiler-inspection departments and the National Board, composed of the heads of these departments, evolves a uniform system for registering all boilers in use and reporting all accidents to them, we shall have some real information. The average intelligence and efficiency of the operating engineer in states requiring examination and license have been raised through the elimination of the unfit and the self-improvement of the others through study to qualify for higher degrees of license, but there has been no restriction of available labor in this field, and the more the men qualified to assume responsibilities the more they identified themselves with the executive class. In this phase the public and legislative minds adjusted themselves to the theorem that the state not only has the right but is in duty bound to safeguard its citizens against ignorance, neglect, or willingness to take a chance on the part of users of power-plant apparatus.

In this second phase the stress was put upon public safety, and safety was insisted upon as the only warrant for governmental intervention. Our correspondent is in this phase and reiterates its aphorisms and arguments. A state inspector may satisfy himself that an applicant for a license is a safe man to trust with the responsibilities that he seeks to assume, but has no right to examine him with regard to his ability and efficiency as an engineer nor to refuse him a license because of his ignorance of engineering except in the rudimental essentials to safe operation.

As the public consciousness became accustomed to this phase, it began to realize that a boiler explosion is more than a local disaster, that it is a communal loss, a setback in the national struggle for industrial supremacy and the human struggle against environment, an impairment of the efficiency with which human labor seeks to improve the condition of the race. In the last analysis it means increased cost which many people who will never hear of the explosion have to pay for many things at first sight only remotely involved.

And then comes the thought that leads to the third phase upon which we are just entering. If a boiler explosion is a matter of public concern, not only because of the loss of life and physical suffering which it involves, but because of waste of resources and impairment of efficiency, why is not continuous and avoidable waste, amounting in the long run to many times the loss concentrated in the spectacular destruction of an exploding boiler, equally if not still more a matter for the attention of the public economist? We are beginning to get glimpses of a coalless world. Has anybody the right to hasten that impoverishment by burning two pounds when one will do? Has he the right to wilfully waste the resources of the nation and pass the cost on to the buyer of this product? May we not contemplate the time when it will appear just as reasonable to insist, upon the ground of general well-being, that the man in responsible charge of the use of the nation's fuel and power be qualified to use it efficiently as well as safely?

The Engineer as a Writer

THIS is an age of striving toward efficiency in the world at large and more forcefully in the power plant. Many times, dealing with antiquated equipment, thousands of engineers have felt that if they could but secure more modern machinery or accessories, the battle for efficiency would be more than half won. Unfortunately, the average engineer is handicapped at the start, since he is unable to present his ideas on paper in a clear and convincing manner. If he does attempt to put recommendations in written form, its appearance is often so slovenly and unattractive as to defeat its purpose.

The practical engineer is not the only one who fails in this respect. There is but a small minority of technically educated engineers who possess the ability to write good English. From his freshman days, when he rather bragged of his "flunk" in English composition, the technical man has disliked, even as has the practical man, to put his thoughts on paper. The result is that when a survey of a plant is required, both types are ignored and an outside engineer who can express his ideas, even though they may not be as good as those of the engineer who has been thrust aside, is called in.

The ambitious engineer will ask how this condition can be remedied. Surely he cannot be expected to attend school again. This is not necessary. All that is required is practice in the expression of his thoughts. If the engineer who has made an improvement or has overcome some operating trouble will attempt to write a concise account of this work, he will be surprised how much easier such reports become after two or three trials. Not only will he find that practice makes him write more concisely, but he will also find himself thinking more logically. Probably the best training an engineer can secure in writing intelligently is in the preparing of short articles for his favorite engineering magazine. Too many engineers think their ideas not worth pencil and paper. It is the universal experience that one mediocre idea well expressed is worth a thousand good ones if they be hidden away under one's own hat.

Bituminous Coal Bulletins Suspended

THE Federal Trade Commission, in its report on the bituminous-coal situation for May, gave warning that unless a sufficient number of operators should voluntarily furnish reports, the bulletin service would have to be discontinued. Now, after waiting a reasonable time, the commission reports that only 555 operators, representing but eighteen per cent of the estimated total bituminous coal mined in the seventy-four mining districts of the United States in June, have turned in their reports for that month. The June bulletin, just released, contains an announcement to the effect that its publication is to be suspended until the courts render final decision on the constitutional power of Congress to authorize the commission to require reports on the cost of production.

It is to be hoped that the courts will uphold the commission; but in the meantime, how does this secrecy on the part of the operators jibe with their very recent utterances at Cleveland as reported in last week's *Power*, indicating their desire, even anxiety, to co-operate with the Government in reducing coal prices?

CORRESPONDENCE

Diesel Engine Efficiency

The editorial on the maximum efficiency of Diesel engines in the Sept. 14 issue of *Power* should interest promoters and operators of this type of engine.

After three years of operation of the Diesel engine in electric power plants and also over a year of work on the development of the same class of engines as applied to submarine installations, it is the opinion of the writer that it lies largely with the operators whether the engine shall be a success or not. Perhaps this is a platitude that is common to any prime mover, but in dealing with internal-combustion engines the interest of the operator in his machine must be far more intimate than is the case with many steam installations.

As a comparison, take first the source of power in the steam plant, which is the boiler, which may provide a constant stream of steam at high pressure so that the engine, even if badly adjusted, may develop considerable power and in many plants be satisfactory to the owners.

In the oil engine there is no outside source of energy, all of the power being developed after the fuel has entered the cylinder. Since this action often occurs in a period of less than one second, it is plain that events must be timed correctly and the parts such as valves and pistons must be tight. Because of the lack of a reservoir of force similar to the steam boiler, the overload capacity is low, often not exceeding 10 per cent.

Right here, speaking of overloads, the attention of the operators of gasoline or oil engines that are not run at constant speeds, whether in marine or automobile work, must be drawn to the fact that in stationary service the prime mover must develop its rated power with a very slight change of speed from no load to full load. We can see where the auto engine on being speeded up can carry the car up heavy grades with comparative ease since the increase of speed means an increase in the power developed. The same is true in marine work, for the speed of the vessel depends on the speed of the propeller. An engine turning an alternator which must maintain a certain frequency has not this advantage.

The comment on the Greeley, Kan., fire is absolutely correct so far as the oil engines not being the cause of it is concerned. It is very apparent that pumps carrying oil at a pressure almost as high as that in the fuel lines to the engine cylinders, should be protected so that the engine room could not be sprayed with oil in case of a fracture of any part of them.

Regarding the efficiency of operation, in the case of the four-stroke-cycle engines running up to 200 r.p.m., the engineer can do much toward attaining good results even if he does not have the use of an indicator or pyrometer. The diagrams from a Diesel engine are, at most, very unsatisfactory for the diagram is not, even at excessive loads, of large area with the events prominently indicated as in the case of steam engines. A valve could be much out of adjustment before it would affect the diagram seriously. For testing the compression pressure, the indicator is very useful in the engines that are built today. In the early Diesel engines, with the pistons and valves tight, a certain predetermined linear clearance would give the correct compression. With these engines, when the valves and pistons were tight, excellent results were obtained even if an indicator were not applied for long periods. The oil was carefully measured of course, and by means of the electrical readings the power and fuel consumption were computed.

With the four-cycle engine the valve that requires setting the most frequently is the one controlling the fuel, and it is a simple matter to keep this in adjustment, and the writer has never seen it done with the use of the indicator. These valves should be tested once each month.

The exhaust and air admission valves are usually operated by large cams with a considerable throw. Since the cams are keyed to the camshaft and it is geared to the crankshaft, there is not much danger of the valve timing being changed unless it is necessary to take the gears off the shaft, in which case, if they are carefully marked, there should be no difficulty in replacing them correctly, or in event of excessive gear-tooth wear.

The space between the tappets should be adjusted from time to time. It is well to remember that in the four-stroke-cycle engine the events are comparatively far apart so that there is plenty of time for the different operations, such as admission of fuel, admission of air, period of compression and period of release, to take place.

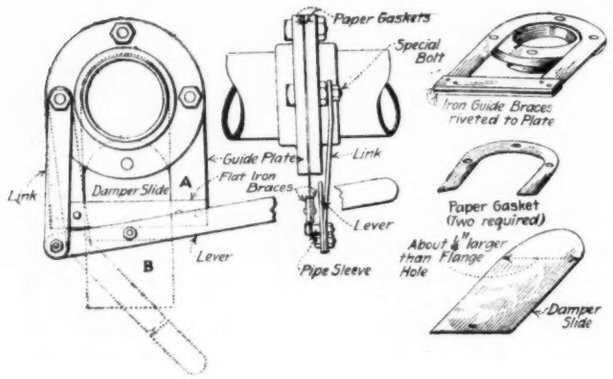
As to the need of a pyrometer, this would tell which cylinder is doing the most work by showing the temperature of the exhaust gases from the different cylinders and would prove interesting to the operators.

The necessary thing to attain is an engineer with common sense. If he is an ex-steam engineer let him make up his mind that he has a machine with many more parts than a steam engine, many more bearings to keep lubricated, low overload capacity, with piston rings apt to stick and allow gases to escape unless frequently examined; and if he remembers to keep the valves tight and the cooling water system in good order, barring accidents good results should be obtained.

East Dedham, Mass. G. H. KIMBALL.

Home-Made Flange Damper

The sketches show the construction of a damper for a low-pressure pipe line, as for instance a blower intake or outlet or an air inlet to a furnace, such a damper being frequently necessary to regulate the amount of air passing through the line. The construction is simple but effective, being a U-shaped piece *A* of heavy sheet iron, either black or galvanized, clamped between two pipe flanges in the line. A slide *B* cut from



DETAILS OF LOW-PRESSURE PIPE-LINE DAMPER

the same material fits into this U, and its width is made about a quarter of an inch larger than the diameter of the flange opening. A gasket of heavy paper set in shellac, paint or other adhesive is clamped between each flange and the outer plate; this gives clearance to the slide. Usually it will be necessary to leave out one of the flange bolts to allow room for the damper slide to enter.

The arms of the U-piece *A*, or guide plate, extend out and serve as guides, two flat iron trips being riveted across the outer ends as shown. The operation of the damper will be greatly facilitated if a lever and link are connected as shown in the sketch, the link being pivoted on one of the flange bolts, which is made longer for the purpose. By using the lever, the slide can be made to work tightly enough to allow of its staying wherever placed as well as to almost entirely prevent the leakage of air. H. H. PARKER.

Oakland, Cal.

Does It Pay to Make Your Own Repairs?

The question of making your own power-plant repairs should be of interest to every progressive engineer, but whether it is cheaper to do so than to have the work done by outside forces is a question. To be sure, a goodly number of articles have been published in *Power*, illustrating and describing how engineers have repaired breakdowns, but most of them were of simple character and could easily have been fixed by anyone having a little mechanical ingenuity. It is seldom, however, that we find an account published of repair jobs that require very much time or labor or where the cost would amount to very much if done by the men in the plant.

Labor costs are about the same whether the work is performed by men in the plant or by an outside shop, and naturally, the labor supplied by the outside shop is more skilled in making repairs than the men employed by the power plant would be, owing to the fact that they are constantly employed in doing such work, whereas the power-plant man has it only occasionally and does not always know the quickest and best way of doing the work.

For instance, not long ago the armature of a generator burned out and the rewinding was done by men employed about the plant. So far as known, no account was kept of the amount of labor put in on the job, and there is a question if the work was done as well or as cheaply as it could have been done by a company engaged in such work. This same thing would apply to boiler and engine repairs.

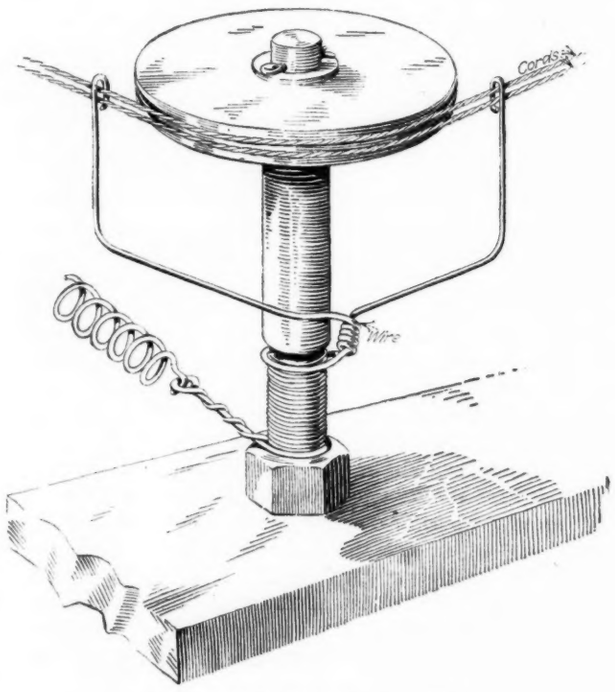
Perhaps some of the readers of *Power* have had repair jobs of some magnitude and have the facts and figures to show that money was saved over what would have been paid to an outside repair company. If there are such instances, accounts of them would be interesting and helpful to other engineers. M. G. GROOM.

Baltimore, Md.

Simple Indicator-Cord Holder

While running a continuous test on a Diesel engine recently, I found that each time I wished to take indicator diagrams, it was necessary to guide the cord through the groove in the pulleys before I could engage the hook in the traveling eye.

To keep the cords in place I used a short piece of wire bent as shown in the sketch. The ends that guide the cord are so bent that, when there is tension on the cord



GUARD FOR INDICATOR CORDS

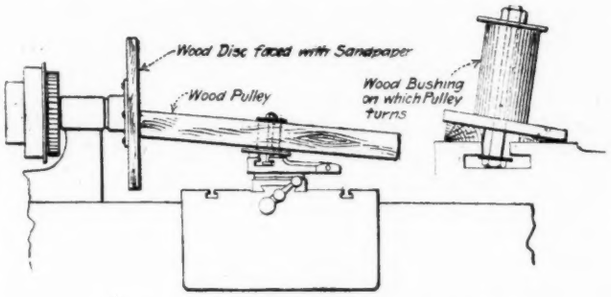
and the indicator drum is revolving, there is enough clearance to prevent interference with the free travel of the cord. Then, when the hook is disengaged, the cord rests against the wire supports and remains in the pulley groove.

As I was obliged to take diagrams very often, I found this simple device a great help. W. E. GREENE.

Buffalo, N. Y.

Crowning a Large Wood Pulley in Lathe

The sketch shows a method for truing up or crowning a wood pulley that is too large to swing in a lathe. A large hardwood or steel disc is bolted to a faceplate and a sandpaper disc glued to its face; this disc should be run at high speed. The pulley is mounted on the tool slide; if to be trued, with its face horizontal, but if to be crowned, wedges will have to



WOOD PULLEY PLACED FOR CROWNING

be set as shown in order to tilt it up to the angle necessary to give the amount of crown desired.

A hardwood bushing is turned up to fit the pulley bore; this is drilled for the clamping bolt. A metal plate is placed between the bushing and the tool block, and the wedges are driven under one edge of the plate. After placing the pulley over the bushing a large washer is put over the bolt to prevent the pulley, which should rotate freely but without play, from working up.

Then the disc grinder is set in motion and the pulley fed carefully up to it by means of the carriage handwheel. It is rotated slowly by hand until half its surface is finished, then reversed and the other half crowned. If a straight face is to be ground, reversing will not be necessary. In the case of a very large pulley or one with a wide face, the disc might have to be refaced with sandpaper before the operation is completed.

H. H. PARKER.

Oakland, Cal.

Ammonia Stores in Coils

In the Sept. 14 issue R. G. Summers tells of trouble with a refrigerating system operating on freezers. The statement is made that the back pressure carried on the machine was fifteen pounds. It is my belief that the trouble is caused by the back pressure being carried too high for freezer work. As the temperature of ammonia due to fifteen pounds pressure is approximately zero, the temperature difference between the ammonia in the coils and the room itself is so small that the ammonia stores in the coils, as indicated by a shortage of ammonia in the receiver. When the expansion valves are opened even slightly this stored liquid is carried to the compressor in the form of a highly saturated gas, thus freezing up the compressor.

In operating freezers the main trouble encountered is the storage of liquid ammonia in the refrigerating coils if the expansion valves are left open for any length of time. The remedy is to determine by trial the length of time the liquid can be fed to a freezer coil or a system of coils without the excessive storing of liquid or the "freezing up" of the compressor. The method of operation will then be to leave the liquid valve open for the determined length of time, then close it and pump down until the compressor discharge begins to warm up well, when the liquid valve is again opened. The liquid is best controlled through a master valve in the engine room to obviate the necessity of setting a number of expansion valves.

If Mr. Summers will try this plan and reduce the back pressure on the machine handling the low-temperature work to five pounds or less, he will have no trouble, assuming that his machine is large enough to handle the load at the reduced back pressure.

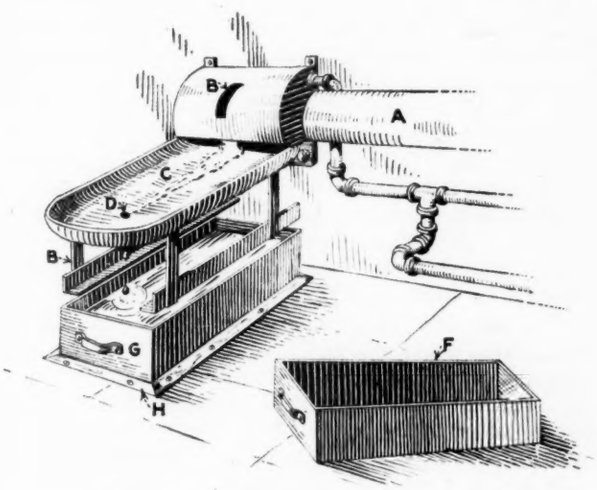
Tuckahoe, N. Y. F. G. SCHOENFELD.

Oil-Pan Arrangement for Ascertaining Fuel Leakage

During a recent economy test on an oil engine I found it necessary to know the amount of fuel oil that was leaking by the fuel-pump plunger. This pump was located over the camshaft *A*, and the plunger was driven by cam *B*. The pan *C* was placed directly under the pump (not shown) and had been draining all the leaking oil through the hole *D* into a pail.

In order to ascertain the exact amount of oil leaking between definite intervals of time, I arranged the apparatus shown in the sketch. The strips *B* were bent and fastened to the under side of the pan *C* by machine screws. Two light pieces of angle-iron were riveted so that the pan *F* would just slide into the pocket formed by these irons, which were made so that the pan fitted snugly enough to prevent sliding out due to vibration. Then the pan *G* was arranged underneath on the floor and held in place by wooden strips *H*.

With this arrangement the oil was allowed to leak into pan *G* until the start of the test. Then the pan *F*



OIL-PAN ARRANGEMENT FOR ASCERTAINING FUEL LEAKAGE

was slid into place and kept there for the duration of the test. For convenience the pan *F* was made to weigh an exact number of pounds.

I found this very convenient in determining the number of pounds of oil that should be subtracted from that drawn from the supply tank by the pump. In calculating the economy of the engine, this fuel leaking past the pump plunger is an important consideration.

Buffalo, N. Y. W. E. GREENE.

Trouble in Burning Hog Fuel

In the Oct. 12 issue, page 592, C. W. Fields mentions having some difficulty in burning hogged fuel under boilers and gives a sketch of the oven in which this fuel is being burned. Unfortunately, the elevation of the drawing is not dimensioned and it is difficult to determine just exactly the shape of this furnace. If the furnace is shaped as shown according to scale, a great deal of the trouble is unquestionably due to the restricted throat, as an open throat is essential for burning wood, whether hogged or otherwise.

In order to burn wood successfully, the burning must be done on the outside and the air must come from the front of the furnace over the fire for the greater part; little, if any air comes through the grates, only sufficient, in fact, to prevent the grates from becoming overheated.

The fuel should be fed through the top chute by gravity, not under air pressure. It would help if the fuel were allowed to pile up in a cone, which would leave all four corners of the grate bare, to allow air to enter at these four points. In addition air should be allowed to enter above the grate through the firedoor or, preferably, rather higher up, and if possible this air should be heated. This can be accomplished by making a double arch allowing the air to enter through the side walls of the furnace between the two arches, then pass downward through openings in the front walls into the firebox. With this arrangement sufficiently heated air in a proper amount can be supplied to the fire to consume the fuel.

If air is forced into the furnace, the blast will carry over the chips and dust unconsumed into the tubes, where the fire in them will be quenched, and the ashes will be blown up into the stack. Sufficient air and fuel should be supplied in the proper proportions so that combustion is completed before the burning particles reach the rear end of the boilers. For this purpose the passage of the gases should not be accelerated by a blast, but should be retarded as much as possible. A wide throat will facilitate this result, and if the setting is properly built the losses in radiation will not be large. As a general proposition the character of the grate has very little to do with the burning of wood. All that is necessary is that sufficient air passes through the grates to prevent their overheating and providing a sufficient amount of heated air over the top of the fire.

We have two boilers operating on hog fuel using only half dutch ovens, owing to the restricted floor space in our boiler room, and we are burning this fuel practically without smoke and developing good efficiency; at least we so judge from the output of the boiler, as we have as yet made no evaporation test. The boiler is rated at 255 hp., and we have taken out over 430 hp. continuously for many days at a time, with little or no trouble as regards clinkers or ash.

Soot blowers are used frequently; that is to say, the tubes are blown out three or four times a day so as to keep them as clean as possible. The combustion chamber does not fill up with cinders; the ashpit is clear and free, even more so than with coal; no trouble is experienced with the grate, and none in keeping the pressure up.

The only difficulties that have been shown so far have been in maintaining the arch and the side walls, for the fire is exceedingly hot and quite variable owing to the difficulty in maintaining a constant feed of the fuel. This latter trouble we are in process of eliminating at the present time, and hope soon to arrange to be able to feed the fuel as the load demands. The question of controlling the air is comparatively easy, as it is done by opening or closing two 4 x 10-in. doors which are located almost directly over the firedoors.

Boston, Mass. HENRY D. JACKSON.

Engineers' License Laws

Referring to the article "Engineers' License Laws" on page 632 of the Oct. 19, 1920, issue of *Power* by W. F. Lockwood, I would say that he reasons only on one side of the question. As I am an engineer, also a member of a board of examiners for engineers, and an employer of eight to ten engineers for the company of which I am the chief engineer, it is my duty to know at least as much as the men I employ, about the engines and boilers in the plant; otherwise, I could not intelligently direct them in the course of their work, especially during the critical periods that sometimes arise in every power plant that is operating.

Mr. Lockwood says that the public is not concerned and that there would be no menace to the public if the valves were faultily set, etc. He does not consider that we are wasting those necessaries of life and health and raising the price of these materials to the public as well as the owner.

Mr. Lockwood says it would make no difference, to the public, if the engine were to run loose in all of its bearings and its thumping could be heard a mile away. I hope that I will never be compelled to live within a mile of his plant, or have to go to a hospital if he should ever be lucky enough to get a position as engineer in the same hospital, or have to send my children to school within a mile of his plant.

For the safety part I want to ask Mr. Lockwood if he ever knew of any accident caused by loose bearings and this thumping that he speaks about. Let him try to calculate the force of the blow against the metal in a thumping engine, and see how much more strain he puts on the engine frame, and then figure how much danger there is to the men and women working in a manufacturing plant where he is employed as an engineer. If he is not able to do this, let him go to some of the examiners in the State House at Boston and get them to do it for him. I know quite a number of them, and I know they can do it. GEORGE T. BROMLEY.

Wilmington, Del.

Referring to Mr. Lockwood's article, I do not wish to suggest that he has not said much truth, but it was conceded that Massachusetts plants during the recent war were far more efficiently operated than plants in no-license states. A flywheel explosion sometimes is quite a serious affair, and the learned engineer tries, by properly adjusted valve gear and governor, to protect his plant from such a catastrophe, although explosions have occurred in plants, as Mr. Lockwood says where licenses obtained.

Our best surgeons and physicians fail to save every patient. Do the majority of engineers and firemen in license states wish to go back to the days before licenses? I think not. Does the progressive citizen wish the law licensing engineers and firemen abolished? I think not. Does Mr. Lockwood wish to embark on a vessel under a licensed captain and chief engineer or otherwise?

New York City. C. W. PETERS.

INQUIRIES OF GENERAL INTEREST

Carbon in Lubricating Oil—After refiltering the lubricating oil in a Diesel engine, I find a lot of carbon particles still in the oil. Can this be remedied? R. G. N.

It is practically impossible to remove all the free carbon from the oil. A small amount will do no damage.

Diesel Hard to Start—In starting a Diesel engine using 26-deg. oil, the cylinders do not fire until the flywheel has turned over a dozen or more times. How can this be improved? D. B.

Evidently the cylinders are worn, losing compression until warmed up by making several strokes. As an emergency, use kerosene to start, since it fires at a lower temperature.

Clattering of Balanced Valve With Circular Back—Our shaft governor engine is provided with a balanced valve that, judging from the large amount of steam used, probably leaks badly, and when the engine is running the valve makes a clattering noise such as made by most engines when started up or stopped. A short time after the valve and circular top-plate were planed and supplied with new packing rings, the noise became as bad as before. How can the trouble be remedied? E. W.

The trouble complained of is common with the type of valve described, especially when the engine is operated with a heavier load than the load for which wear has caused shoulders to be formed on the steam-chest cover. For the greater valve travel with heavier loads, the circular edge of the top plate strikes these shoulders or travels over them with a chattering of the valve. The only remedy is to make frequent inspections of the surfaces and keep them true and parallel, and keep in order the springs that hold the valve-back against the steam-chest cover.

Chatter and Blow-down of Safety Valve—Why does a safety valve continue to blow off after the boiler pressure has dropped below the pressure for which the valve is set? What would cause a safety valve to chatter or rumble when blowing off? C. T. C.

Blowing off continues after the boiler pressure is reduced below the "pop" pressure because the discharge passages guide the escaping steam in such a manner that it helps the boiler pressure to hold the valve away from its seat. The greater this assistance while the valve is open the lower the boiler pressure will be reduced below the "pop" pressure before the valve will be closed. The reduction in boiler pressure below the "pop" pressure is called the "blow-down" and most direct spring loaded safety valves are provided with an adjustable "blow-down ring" or other means for varying the amount of blow down. When the valve is raised from its seat the pressure exerted by the spring is greater than when the valve is closed. Hence when the valve opens, unless the escaping stem exerts enough force to overcome the greater spring resistance, for continuance of a little more than pop pressure in the boiler there are rapid alternations of partial openings and closings, due to the ricochetting of the spring and small sudden changes of boiler pressure that give rise to chattering of the valve with intermittances of discharge, causing vibrations of the atmosphere that produce a humming or rumbling sound.

Anchorage for Base Elbow of Turbine Exhaust—A steam turbine running under 28 in. vacuum has a 30-in. diameter exhaust opening to which a copper expansion joint is bolted, and there is a base elbow bolted to the expansion joint, which is anchored to a concrete pier. What should be the weight of the pier? R. J. D.

A vacuum of 28 in. $= 28 \times 0.491 = 13.75$ lb. pressure per square inch less than the pressure of the atmosphere. The area of opening of the elbow is $30 \times 30 \times 0.7854 = 706.86$ sq.in. Assuming perfect flexibility of the expansion joint and elbow connections and neglecting the weight of the elbow, the excess external pressure tending to lift the elbow and weight of concrete required for its anchorage would be $13.75 \times 706.86 = 9{,}719$ lb. The actual weight of concrete required would be reduced by the weight of the elbow and any upward thrust exerted by the expansion joint.

Reconnecting Induction Motor—We have a 60-cycle 440-volt 150-hp. 720 r.p.m. motor. This machine when it came from the factory was connected five-parallel for two-phase. Without removing any of the coils somebody connected it five-parallel-star for three-phase. In the two-phase winding the coils were arranged in groups of four. In the three-phase winding one coil has been left dead in each group, and this motor is operating satisfactorily. In other words, there are now only three active coils in each pole-phase group. What effect has the change on the horsepower rating and speed of the motor? W. H. K.

A two-phase motor connected star for three-phase operation, using the same grouping of coils as for the two-phase machine, will be correct to operate on 125 per cent of the two-phase machine's volts. With the motor in question, the winding was grouped in five parellels for two-phase and was correct to operate on 440 volts. If this same winding was grouped five-parallel-star for three-phase it would be good for 125 per cent of 440 volts or 550. However, 25 per cent of the coils have been left inactive in the winding, consequently the motor is now only good for operation on 75 per cent of 550 or 412.5 volts, and will act the same as though it was on a circuit of 106 per cent normal volts. No doubt the motor is conservatively enough designed so that it will operate satisfactorily under the new condition. Since the copper has been reduced by 25 per cent, the output will be normally reduced by 25 per cent and the rating will be 75 per cent of 150 or 112.5 horsepower. Since the motor is operating satisfactorily under conditions equivalent to 6 per cent increased voltage, it is probably good for about 80 per cent of its normal rating, or 120 horsepower. The starting torque and pull-out torque will be only about 80 per cent of that developed by the two-phase winding, but the speed will be practically the same for either two- or three-phase. To materially affect the speed the frequency on the number of poles would have to be changed.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor]

Automatically Controlled Substations for Industrial Service*

R. J. WENSLEY
Switchboard Engineer, Westinghouse Electric and Manufacturing Company

WHILE the automatic substation has been principally exploited for use by the electric railways, the past year has witnessed a decided awakening on the part of industrial power systems and central stations having Edison systems to the desirability of eliminating the human element from the operation of rotary transforming and converting equipment. In many instances in the industrial field the direct-current system is the outgrowth of small isolated plants with one or more generators driven by reciprocating engines. As the industry grows this plant is extended until a large investment is tied up in direct-current motors. When the plant area grows to more than one or two acres the problem of transmitting power at 125 or 250 volts becomes quite serious and very expensive. The investment in copper feeders is a large factor as well as the actual I^2R losses in the feeders. In most cases these losses are not as serious as the decrease in production due to the slowing down of machines which, of course, follows the drop in voltage. This cannot be avoided without the expenditure of unreasonably large sums for copper. It is undoubtedly true that many of the industries in this class would be better served by the exclusive use of alternating-current distribution, but in many cases the cost of changing over the equipment is absolutely prohibitive. Notable examples of this class of industry are the Detroit plants of the Packard and Ford motor companies. Both of these companies are turning to the automatically controlled substation as a way to solve the direct-current distribution problem.

There are other classes of industry that require large amounts of direct-current energy—for instance, the steel mills. Without going into the merits of alternating-current versus direct-current drive, in this instance the fact remains that numerous extensive and high-capacity direct-current systems are maintained by the larger mills and are constantly being extended. The use of automatic or semi-automatic control for the converting machinery offers a convenient and economical method by which good regulation can be obtained for the least initial investment.

Use of Substations in Mines

Large mining industries are compelled to use direct current at a potential not exceeding 275 volts for the locomotives that haul the dump-cars from the mines. The tracks of these miniature railway systems quite often spread over an appreciable area and thus require that current be fed to the system at more than one point. The least expensive method of accomplishing this is by the use of automatically controlled converting equipment installed underground at points as close to the load centers as convenient The first use of this means of distribution to come to the writer's attention is by the Lincoln Coal Co. operating near Johnstown, Cambria County, Pensylvania.

In the past year or so there has been a marked tendency on the part of users of electric power to eliminate the human element in the starting of motors driving various sorts of machinery, so as to avoid both the abuse of the motor and the necessity for educating the machine operator in the exceedingly simple starting operation. As the use of such automatic starters is now so universal and as many of the operating principles of the automatic substation are similar, factory electricians are well prepared to undertake the maintenance of the latter.

Labor of the sort available for operating manually controlled converting apparatus has become, in the last few years, both expensive and inefficient. Few of the operators are able to do more than call for help if any operating difficulties present themselves. If they attempt to go ahead on their own initiative they are likely to make expensive errors in judgment that will result in even more extensive trouble than the first encountered.

On the other hand, the designers of electrical machinery have been improving methods and materials until it is now possible to construct apparatus that can be reasonably expected to give long service with a minimum of lost time for repairs. Experience gained in the railway field has shown that automatic control can be made so nearly perfect that with any sort of reasonably good maintenance the service should be equally as good as the best manual operation, or very possibly much better, especially as regards speed of service restoration after a failure of the primary power supply.

Automatic Control Reliable

An instance of the performance obtained is that of the automatic railway station installed on the Lima-Toledo division of the Ohio Electric Railways. After about two years of operation there was a strike in which the maintenance crew joined. This station operated for some six or eight weeks with no inspection or maintenance service of any sort. Unfortunately, the use of this incident as a shining example is spoiled by the fact that a severe electrical storm burned out the direct-current reverse-current relay at the end of this period, and the man responsible for operation was unwilling to take a chance on allowing the equipment to function without this protective feature. This shows, however, that the automatic control does not have to be petted and nursed along daily to keep it operating.

Criticism of the complexity of the wiring connections in the automatic control for converting machinery has died out to a considerable extent, due both to the effort on the part of the designers to simplify the connections and to comparison with such equipment as the controls of paper-mill machinery or large reversing rolling mills. Beside the diagrams of such equipments the automatic substation seems almost elementarily simple.

The tendency is for the use of synchronous-motor generator sets in industrial plants. In fact, all the equipments actually sold for use in industrial automatic substations, so far as the writer knows, are of this class. The largest and most interesting of these are the two being installed by the Packard Motor Car Co. at its Detroit plant. Each of these will have one 1500-kw. synchronous-motor generator set with a 4600-volt three-phase 60-cycle motor and 250-volt direct-current generator, the latter equipped with compound, interpole and distributed compensating-field windings. For full automatic operation the compound winding will be short-circuited, the regulation being obtained from a special form of regulator.

Packard Plant Installation

The Packard plant is laid out on a long narrow strip of ground directly adjoining a railroad on one side. The existing direct-current power plant is near the center. Power is transmitted in either direction through cables laid in a tunnel. All the cables of each polarity are paralleled so as to form one heavy bus. As the load is growing toward the ends of this bus tunnel it has been decided to put in two automatic substations near the heaviest load centers located farthest from the generating plant. Power for these stations will be purchased from the Detroit Edison Co.

The control equipment has been built for full automatic operation, this meaning that the stations will start up when the bus voltage is reduced below a certain point and will be shut down when the load remains less than a predetermined value for a given length of time. It may prove more

*Abstract from a paper presented before the Providence Section of the American Institute of Electrical Engineers, Oct. 8, 1920.

satisfactory, however, to control the starting and stopping of these stations by means of pilot wires from a central point, as the load grows with such extreme rapidity in the morning and immediately after the noon hour.

Automatic converting stations are, in general, applicable to any sort of industrial requirement where operating labor can be saved by their use. Proposals have been made for their use in all sorts of mills and factories, motion-picture studios, electrolytic industries, mines and many other applications. In some instances the prospective purchasers have been more eager to eliminate the troublesome operator than to save the cost of operating labor. The problem of keeping maintenance men seems much easier. The automatic substation will continue to operate for quite some time without a maintenance man, but the manually operated equipment will not run without its operator.

Modern Development in the Use of Pulverized Fuel

In the United States 85 per cent of the power and heating plants do not run over 1,000 hp., and the expense of a complete pulverizing plant has been prohibitive. This problem is now being solved by a centralized pulverizing plant, delivering the pulverized fuel to the consumer in tank wagons, according to a paper by C. L. Bohannan, combustion engineer of the Bonnot Co., before the Minneapolis Section of the National Association of Stationary Engineers.

The Hennepin Atomized Fuel Co. is now erecting a pulverized-fuel plant in Minneapolis to supply pulverized fuel for boiler plants and for power and heating plants. As soon as the installation at this point is completed, the company will begin erecting plants in St. Paul and Duluth, and eventually will have a network of them in the State of Minnesota. The plant is being built by the Bonnot Co., of Canton, Ohio, which will also furnish the burning equipment for the various installations.

The peat operations of the Hennepin company have now passed the experimental stage, and it is expected that a considerable amount of this fuel will be on the market by the fall of 1921. The work of excavating and air-drying the peat has been done on a 60-acre tract, situated three miles from the city limits of Minneapolis on Superior Boulevard. The peat on this bog averages about seven feet in depth and is not as high a grade of fuel peat as that found in the northern part of the state, where the depth is from twelve to twenty-five feet. This peat is much more compact and of an older formation. It is excavated by the Garnett peat machine, which digs, macerates, spreads and cuts into briquets at one operation. This machine requires only one man to operate and has a capacity of 100 tons of air-dry peat per day. After the peat is spread, the crop is allowed to lie for about two weeks, exposed to the wind and sun, when it is piled into windrows by the use of an ordinary road scraper for further air drying, and put into stockpiles to await transportation to the pulverizing plant.

The dry pulverized peat contains about 3 per cent moisture, 10 per cent ash, 0.32 per cent sulphur and from 9,000 to 10,000 B.t.u. per lb.

The experimental work of burning pulverized peat was conducted at the Phœnix Building, Minneapolis, with very satisfactory results. The actual comparison obtained by a weighed water test showed that about 10 per cent more peat was required to carry the same load than when burning pulverized coal.

Pulverized peat burns with a longer flame than pulverized coal, due to its high volatile content and weight. A cubic foot of pulverized coal weighs 36 lb., while a cubic foot of pulverized peat weighs 31 lb. From the nature of the fuel, with its high oxygen content, the quantity of air for combustion can be greatly reduced from that required for coal. A slight variation in the air supply will affect the furnace conditions with peat burning more than the same variation where coal is used. The ash is very light and does not stick to the tubes.

The Bureau of Mines, University of Minnesota, estimates that there are, in that state alone, seven billion tons of peat, the greater portion of which is available for fuel. The burning of pulverized peat, while a new departure in this country, has been in successful operation in Sweden for several years. Results of tests by the Swedish government are summarized by Captain Ernst Wallagren, Chief Peat Engineer of that government, who says: "The peat powder, when burned by the method used at Bäck, was equal in fuel value to the best English coal ton for ton. This discovery makes Sweden independent of other countries for fuel supplies for industrial uses."

In summing up, Mr. Bohannan declared it to be an absolute fact that the use of pulverized fuel produces a great saving in both fuel and labor costs. Owing to the scarcity of skilled operators, it is more difficult than ever to produce high efficiencies in hand or stoker firing. For these conditions pulverized fuel gives an ease of control equivalent to that of a gas or oil fire.

Increased Operating Costs

In a paper, "Operating Costs—Power Expenses," presented before the Municipal Tramways Association, Cardiff, Wales, A. L. C. Fells said in part:

Before the war it was possible to issue a fairly close specification for coal, and payment was made for value received. Since 1914, however, anything available has had to be taken, and absolute rubbish has been supplied in innumerable instances, notwithstanding all the complaints made to the authorities concerned.

To-day the situation is still unsatisfactory. The following particulars with regard to the coal supply to the London County Council's Greenwich Power Station may be of interest:

	1913-14	1919-20
Tons of fuel burned	166,040	176,400
Total cost of fuel burned	£139,577	£348,395
Average price paid per ton for coal	16s. 9¾d.	41s. 11$\frac{1}{10}$d.
Average calorific value British thermal units	13,350	10,780
Average percentage of ash	6.79	14.59

It will be seen that the fuel supplied in 1919-20 contained 7.8 per cent. more ash than that supplied during 1913-14, or a total increase in the waste material supplied to the station of 13,759 tons. This waste material, paid for at 41s. 11.3d. per ton, represents a dead loss of £28,854 during the year. In addition, the extra cost of barging away the ashes at 3s. 8d. per cubic yard amounted to £6,306, and owing to the increasing cost of labor this figure will become more serious as time goes on. The present cost of barging amounts to 4s. 9d. per cubic yard, or a total cost of barging the above quantity of ash would amount to approximately £8,170. In addition to this, it has been necessary to incur very heavy expenditure at the station for labor in connection with the removal of ashes. The figures quoted would have been considerably higher, as a larger amount of fuel would have been consumed in 1919-20, if it had not been possible to bring into commission more economical generating plant.

Dr. Steinmetz Speaks on Lightning

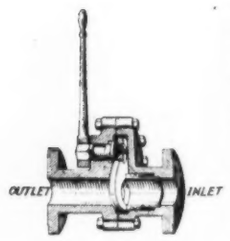
On the evening of Oct. 20 Dr. Charles P. Steinmetz addressed a Chicago audience that taxed the capacity of Fullerton Hall. The occasion was a joint meeting of the Chicago Section of the American Institute of Electrical Engineers, the Electrical Section of the Western Society of Engineers and the Chicago Chemists' Club. The topic of the evening was the "Origin and Energy of the Lightning Flash." According to the speaker's conception the lightning flash is not a destructive charge like that from a condenser, but is more in the nature of an equalization of unequal electrostatic charges. The tremendous power required for a destructive spark is not present. The origin of the tremendous voltages may be in a combination of highly charged moisture particles into raindrops, the charge carried by the small particles being due to their position in the electrostatic field surrounding the earth.

There was 35 per cent less coal produced in the mines of Upper Silesia in 1919 than in the previous year; 21,204,043 tons of coal was shipped from these mines in 1919, as against 36,113,360 tons in 18 and 40,337,215 tons in 1913.

Condensed-Clipping Index of Equipment

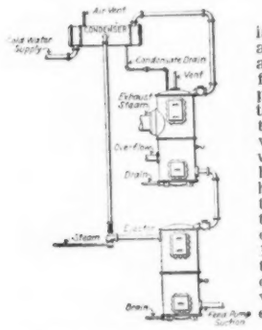
Clip, paste on 3 x 5-in. cards and file as desired

Yarway Double-Tightening Valve
Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.
"Power," 1920



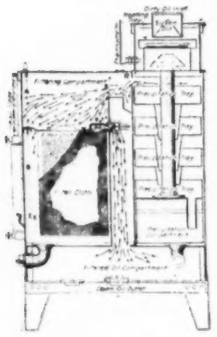
This valve is of the lever operated, swing-gate type, having a seating bushing on the inlet side of the disc so that it is double tightening on both sides. A guard on the tailpiece of the sealing bushing protects the spring and prevents scale-forming matter from getting behind the seating bushing and interfering with the spring action, which keeps the seating bushing against the disc when no pressure is on the valve. When pressure is applied, the seating bushing is forced against the machined surface of the gate disc and is ground in as is the opposite face of the gate as it passes across the seat.

Air Separating Process
The Elliott Co., Pittsburgh, Pa.
"Power," Sept. 14, 1920



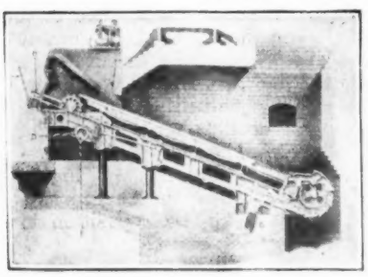
The purpose of this air separation is to remove the dissolved gases and also one class of dissolved solids which are found in natural water as it is fed to boilers. Fundamentally, the process consists of heating the water to its approximate boiling point and then injecting it into a chamber under vacuum. The vacuum is maintained with an air pump with a condenser or heat exchanger in series so that all the heat from the vapor exhausted from the region of vacuum is returned to the feed-water heater through the heat exchanger. The process operates at 100 per cent efficiency thermally, but thermodynamically, the energy loss due to pumping from the region of vacuum slightly lowers the over-all efficiency.

Filter, "Type A" Power Plant Oil
The Richardson-Phenix Company, Milwaukee, Wis.
"Power," Aug. 31, 1920



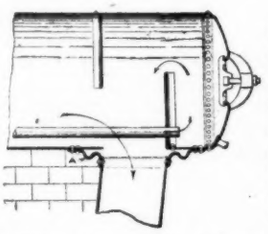
This filter operates on the so-called dry principle of filtration, in which the oil is not passed through water. It accomplishes purification, both by precipitation and by filtration through closely woven cloth. In the former process, the oil is brought practically to a rest and entrained water and heavy particles of foreign matter are allowed to settle out. The incoming dirty water is heated. The oil takes a long path flowing at low velocity over shallow trays, where precipitation takes place. It then flows through the filtering medium. When necessary, the oil is passed over cooling coils after it has been filtered. The clean oil occupies all the space in the bottom of the filter under the precipitation and filtration compartment and also the space alongside the filtering compartment, which is about one-half the width of the filter.

Stoker, Stowe Forced-Draft
Laclede-Christy Clay Products Co., St. Louis.
"Power," Oct. 19, 1920



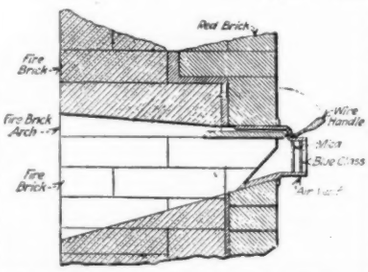
This forced-draft stoker consists of traveling chain-grate elements alternating with stationary tuyeres. The grate is inclined at an angle of 20 deg.; both moving and stationary grates are provided with relatively small area air space through which air is forced at a uniform draft pressure not exceeding 2 in. of water. The chains are made up of four rows of links and are adjusted by eccentric pins. The tuyeres terminate in sharp vibrating bars that slowly rise above and then drop below the chains. In the upper position they start the movement of the fuel and in the lower position permit the chain to carry the refuse to the ashpit. The tuyere rockers are actuated by eccentrics.

Flange, Purifier and Corrugated Boiler
Union Iron Works, Erie, Pa.
"Power," Sept. 28, 1920



A corrugated flange connection is made between the header and the steam drum in order to take care of expansion and contraction. The flange provides an opening of large area for unrestricted water circulation, and requires no throat bracing. Flange connections are made riveted. The purifier consists of a settling chamber, into which the feed water discharges, and where the precipitates and solids are removed from the water before it passes into the drum. Each settling chamber is equipped with a blowoff. Baffles isolate the purifier and conducting water from the rest of the boiler, without obstructing the circulation from the front to the rear of the drum.

Furnace Door, The C-E-Z.
Curry & Barnum, Box 706, New Haven, Conn.
"Power," 1920

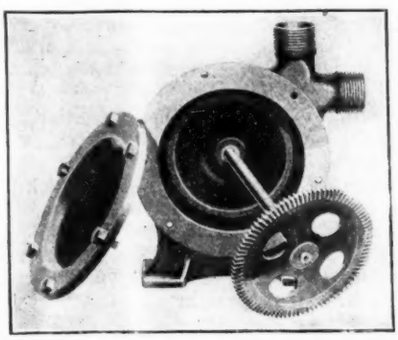


This door is composed of a cast-iron frame, with an opening approximately 2 x 6 in. When not in use the cast-iron flap, about ⅛ in. thick, is closed and in such position protects the door and slab. When the condition of the fire is to be determined, it is merely necessary to pull the handle down and observe the fire. In this 2 x 6 in. opening there is a piece of blue glass which in turn is protected when the flap is up by a piece of mica placed in front of the glass. Between the mica and blue glass there is always a circulation of air. The use of this door obviates the necessity of opening the firedoor for observation. Furthermore, the observer is protected from the intense heat of the furnace when observing the fire.

Packing "Metalpac" Flexible Metallic
Goodsell Packing Co., Maywood, Ill.
"Power," Oct. 19, 1920

This packing is composed of continuous metallic sheets that are passed through a bath of lubricant and crinkled so that the material on the inside of the braided copper-wire covering with which it is wound is as pliable and compressible as the outer surface. The copper braiding prevents flaking of the inner material and also permits of making the packing in continuous lengths. It has the flexibility of fiber packing and is made to withstand the highest pressure for steam, air, vapor, hydraulic pressure and all liquids. It is supplied on reels, in gasket shape, rings and spiral coils.

Pump, Westco
Western Pump Co., Davenport, Iowa.
"Power," 1920



The Westco pump has but one moving part, which is a disc impeller fastened to the shaft, and has a certain determined number of blades on each side of the outer rim. The impeller, rotating at high velocity in the water channel, causes the water to be drawn from the source of supply and discharged under pressure at the outlet. The water is taken in at the periphery and discharged at the periphery. It is used to handle small and large quantities of water under all pressures.

Patented Aug. 20, 1918

Work of the Engineering Standards Committee

Considerable progress has been made on the comprehensive program of safety codes being undertaken by a large number of organizations under the auspices and rules of procedure of the American Engineering Standards Committee. Following this regular procedure, each code is being formulated by a sectional committee, broadly representative of the interests concerned and composed primarily of representatives designated by the various bodies interested in the particular code. The sectional committee is organized by one or more bodies designated for the purpose by the American Engineering Standards Committee and known as sponsors.

Sponsorships for the following safety codes have been arranged for: Construction Work, Electrical Fire Code, Electrical Safety Code, Floor Openings, Railways and Toe Boards, Lighting Code, Lightning Protection, Machine Tools, Mechanical Transmission of Power, Industrial Sanitation Code, Stairways, Fire Escapes and other Exits, Textiles, Abrasive Wheels, Foundries, Gas Safety Code, Head and Eye Protection, Paper and Pulp Mills, Power Presses, Pressure Vessels (Non-fired), Refrigeration (Mechanical), Woodworking Machinery.

The Head and Eye Protection Code has been completed, and the sponsor, the Bureau of Standards, has submitted the code to the main committee for approval.

Specifications and tests for portland cement, and specifications for fire tests of material and construction have been approved by the committee as Tentative Standards. The committee has under consideration several other standards covering specifications for materials.

A specification for standard pipe threads has been approved as an American standard. The American Society of Mechanical Engineers and American Gas Association are sponsors and are representing America on the subject at an international conference in Paris.

A sectional committee on steel sections is actively at work, the Association of American Steel Manufacturers, the American Society of Civil Engineers and the Society of Naval Architects and Marine Engineers having accepted sponsorship. The American Bureau of Shipping and the United States Navy have representatives on this sectional committee. Real progress has been made and steps taken toward agreement with the British Engineering Standards Association.

The Swiss have requested co-operation on standards for ball bearings. The American Society of Mechanical Engineers and Society of Automotive Engineers have accepted the sponsorship, and a sectional committee is now being formed.

The British have asked for co-operation on standards for gears. The American Society of Mechanical Engineers has accepted sponsorship and has invited the American Gear Manufacturers Association to act jointly with them.

Plans are under way for sectional committees on screw threads and on cylindrical limit gages for co-operation with the British association. The main committee has a satisfactory understanding on screw threads with the National Thread Commission.

At a safety-code conference in Washington, Dec. 8, 1919, a resolution was passed expressing the opinion that safety codes for general use should be prepared according to the procedure of the American Engineering Standards Committee. A second resolution requested the American Engineering Standards Committee to ask the International Association of Industrial Accident Boards and Commissions, National Safety Council, and Bureau of Standards, to form a safety code committee, which should suggest a list of safety codes and recommend sponsors. The American Engineering Standards Committee acted favorably upon this request. The committee appointed has made a progress report, suggesting 37 codes.

The American Engineering Standards Committee is in communication with similar organizations in Belgium, Canada, France, Great Britain, Holland, Sweden and Switzerland.

The committee will be of great help in co-ordinating and furthering standardization work, thus helping to place industries at large in a position to increase production. The economic advantage to the whole country of any movement that would tend to increase production is obvious.

Upon request of the American Institute of Architects and the Elevator Manufacturers' Association of the United States, a conference of the various bodies interested in the question of the standardization of elevators was called by the committee to decide whether such standardization work should be undertaken, and if so, what the scope of the work should be. The conference was held in New York on Sept. 21, and was attended by representatives of thirteen different organizations. After a full discussion, the following resolution was unanimously voted:

Resolved: that this conference fully recognizes the need and the desirability of standardizing such features of both passenger and material-handling elevators as capacities, platform sizes and methods of test.

Acting upon a request from the Secretary of the International Aircraft Standards Commission, that arrangements be made, if possible, for American participation in the next meeting of the commission, the American Engineering Standards Committee invited the various government and industrial organizations interested in aircraft standardization to send representatives to a conference to discuss the question. It was the uanimous view of this conference, which was held in Washington Aug. 11, that there should be American participation. A committee was appointed to present the matter to the President through the chairman of the Council of National Defense. As a result, the President addressed a letter to the National Advisory Committee for Aëronautics, requesting it to arrange for the presence of American representatives at the conference. The National Advisory Committee for Aëronautics is taking steps to provide such representation.

There has been formed in Austria a national engineering standardizing body. It is the tenth to be formed, the others being in Belgium, Canada, France, Germany, Great Britain, Holland, Sweden, Switzerland and the United States.

Coal Still Scarce In Spite of Lifting of Lake Priority Order

The lifting of the Lake priority order has had the effect of releasing one-half of the 4,000 cars that have been dumped daily at lower Lake ports. During the latter part of the time that the Lake order was in effect, the refusal of the Northwest to buy resulted in a large number of cars being held under load. With the lifting of the order this accumulation of coal on cars was hurried into distribution with the result that very substantial relief was felt in the Middle West during the week following the cancellation of the Lake order. This gave rise to the hope that the movement would continue at that rate, and some disappointment is resulting because deliveries have slowed down.

The public utilities continue to be very uneasy about their car supply, and the Interstate Commerce Commission was asked formally on Nov. 1 to invoke service order No. 21 so that the use of assigned cars could be permitted. The commission declined to take that action on the plea that general conditions throughout the counry, among the public utilities, do not warrant a return to assigned cars.

Registration of Engineers in Canada

The Engineering Institute of Canada some time ago proposed a plan for the registration of engineers. Since that time the Canadian government has framed a law along the same general lines, providing for associations of engineers in each province. General rules of procedure were laid down by the government, by which these associations might register engineers as members. Such registration has the same effect in Canada as the licensing of an engineer has in some states in this country. There is this difference, however: In the United States the licensing of engineers is in the hands of a board appointed by the government of the state, while in Canada the situation is almost entirely in the hands of the engineers themselves.

Progress of Federated American Engineering Societies

The American Institute of Electrical Engineers at a meeting of its board of directors on Oct. 8 appointed the following representatives of the institute on the American Engineering Council, the governing body of the Federated American Engineering Societies: Comfort A. Adams, Cambridge, Mass.; A. W. Berresford, Milwaukee, Wis.; H. W. Buck, New York City; F. L. Hutchinson, New York City; W. A. Layman, St. Louis, Mo.; William McClellan, Philadelphia, Pa.; L. F. Morehouse, New York City; L. T. Robinson, Schenectady, N. Y.; Charles S. Ruffner, New York City; L. B. Stillwell, New York City; Calvert Townley, New York City.

The Florida Engineering Society has appointed L. R. McLain to represent it at the first meeting of American Engineering Council, Nov. 18 and 19, 1920.

The Federated American Engineering Societies now consist of the following organizations: Alabama Technical Association, Birmingham, Ala.; American Institute of Chemical Engineers, Brooklyn, N. Y.; American Institute of Electrical Engineers, New York City; American Institute of Mining and Metallurgical Engineers, New York City; American Society of Agricultural Engineers, Ames, Iowa; American Society of Mechanical Engineers, New York City; Detroit Engineering Society, Detroit, Mich.; Engineering Association of Nashville, Nashville, Tenn.; Engineering Society of Buffalo, Buffalo, N. Y.; Florida Engineering Society, Gainesville, Fla.; Kansas Engineering Society, Topeka, Kan.; Technical Club of Dallas, Dallas, Tex.; The Cleveland Engineering Society, Cleveland, Ohio; The Society of Industrial Engineers, Baltimore, Md.

Twenty-seven additional societies have been invited to become charter members and are now considering the question of acceptance.

New A. S. M. E. Officers Chosen

The American Society of Mechanical Engineers has completed its letter ballot for new officers. The successful candidates will take office after the annual convention of the society early in December. Edwin S. Carman, a Cleveland manufacturer, was selected as the president for a term of one year. The new vice presidents, who will serve for two years, are: John L. Harrington, a consulting engineer of Kansas City; Leon P. Alford, a New York editor, and Robert B. Wolf, president of the R. B. Wolf Co., of New York. The three managers, who are to serve for three years, are Henry M. Norris, of Cincinnati, Ohio; Carl C. Thomas, of Los Angeles, Cal., and Louis C. Nordmyer, of St. Louis, Mo. Major William H. Wiley, a New York publisher, was re-elected treasurer. The society's council will choose the secretary in December.

Prominent Engineer Dead

Percy B. Taylor, Newark, N. J., a prominent consulting engineer, died at his home in that city on Oct. 21, after many months of illness due to heart trouble. Mr. Taylor was born at Manchester, England, May 26, 1865, and came to this country when eight years of age. He started as a young man at the plant of Cyrus Currier & Sons, manufacturers of machinery, Newark, and for many years was associated with this organization, becoming head of the engineering department. He later formed the Taylor-Martin Co., and with a plant on New Jersey Railroad Avenue this company engaged in the manufacture of special machinery and equipment. In 1897 Mr. Taylor dissolved this organization to engage independently as a consulting engineer in mechanical and electrical work, making a specialty of power-plant installations.

For a number of years he was employed as consulting expert by the Board of Education for the installation of heating and ventilating equipment in the local public schools. In his later years he undertook complete plant construction, including power and electrical installations and machinery. He designed a successful internal-combustion engine of special type, automobile transmission and other mechanisms.

Mr. Taylor is survived by a widow, a daughter, a son and two brothers. The son, Kenneth H., will continue his father's business with Robert Bolton, who was associated with Mr. Taylor for fourteen years. Mr. Taylor was a member of the American Society of Mechanical Engineers.

A. S. M. E. Organizes Special Sections

The American Society of Mechanical Engineers has organized in the past seven months seven professional sections and is planning to organize four more. The seven sections already in existence, with the number of members so far registered in each, are as follows: "Aëronautic, 201; Fuels, 498; Machine-Shop Practice, 557; Management, 921; Materials Handling, 605; Power, 920; Railroads, 396. Those not yet organized are: Cement, 92; Gas Power, 322; Ordnance, 172; Textiles, 258.

The object of these professional sections is to provide organizations of members who are particularly interested, and others who may affiliate with them, with means for promoting the arts and sciences of the several branches of engineering included in the scope of the society's activities. The affairs of the sections will be in the hands of a standing committee, which will consist of the chairman selected by each of the various professional sections. The chairman of the standing committee so formed will have a seat in the Council of the society.

Plan to Increase Endowment of Engineering Foundation

The Council of the American Society of Mechanical Engineers has passed a resolution to the effect that the officers of the society be authorized and requested to co-operate with the officers of Engineering Foundation and the officers of the Societies of Civil, Mining and Electrical Engineers in promulgating a plan for increasing the endowment of Engineering Foundation and that when the plan is adopted the officers of this society are authorized to circularize the membership of this society with reference thereto.

The Board of Directors of the American Institute of Mining and Metallurgical Engineers has passed a similar resolution providing that the officers of this institute are authorized to co-operate with the officers of Engineering Foundation and with the officers of the other Founder Societies in formulating and assisting in carrying out a plan for increasing the endowment of Engineerig Foundation. The officers are also authorized to circularize the membership in furtherance of this plan.

Under average conditions an automobile discharges exhaust gases containing about 6.4 per cent of carbon monoxide and about half this percentage of hydrogen according to the tests of the Bureau of Mines. This investigation was reported by A. C. Fieldner, supervising chemist of the Pittsburgh station of the Bureau, in an address before the Chemical Society of Washington on Oct. 28. The work was done by the Bureau of Mines for the New York-New Jersey Tunnel Commission, in order to determine the extent to which ventilation of the tunnel would be essential for proper reduction of the carbon-monoxide content of the atmosphere of the tunnel. With the tunnel operating at full capacity a discharge of approximately 400 feet of carbon monoxide per minute would be expected from these results. This means that the proper elimination of these exhaust gases requires the supplying of approximately one million cubic feet of fresh air per minute.

The French Commission reports that the development of water power in France under plans now being carried out will make that country third among the nations who lead in this respect. The water power resources of France are reckoned to be about 9,000,000 hp. Of this amount 1,165,000 hp. is in use, and about 500,000 hp. additional is being developed. In about fifteen years 6,000,000 hp. more should be realized.

Obituary

Professor E. M. Shealy, who for a number of years was associate professor of Steam Engineering in the University of Wisconsin, died recently at his home in Madison, Wisconsin. Professor Shealy's health had been impaired for some time prior to his death. Outside of the University of Wisconsin, he was probably best known in the field of practical power-plant operation for his excellent works entitled "Steam Boilers," "Heat" and "Steam Engines," prepared by him in the Extension Division of the University. In these books, Professor Shealy demonstrated his thorough knowledge of power-plant operation and his ability to describe it and explain it in language understandable to the practical steam plant operator.

George Tangye, an English engineer of the old school, died recently at his home, Heathfield Hall, Hansworth, England. He was born in 1835, and after completing his schooling at the age of 18, he joined his brother Richard as a clerk in a railway-supply factory at Birmingham. They were soon joined by James and Joseph, but they did not remain long in this place, for Richard soon started in business for himself and it was not long before all the brothers had left. In 1858 they pooled their experience and their ability and established themselves in business as machinists. The Tangye brothers were all mechanically inclined and were brilliantly gifted, so it was only natural that their efforts should meet with singular success. Probably their first notable achievement was their hydraulic jack, which was used to move the "Great Eastern" when she stuck on the launching ways, and which has not been materially improved upon to this day. In 1862, it is said that George conceived the idea of a steam engine that could be built in numbers with the various parts interchangeable, and that his brother James carried the plan into execution, producing what has been known as the Tangye engine. Heathfield Hall, where Mr Tangye was born and where he lived for some years and finally died, was formerly the home of James Watt. Mr. Tangye carefully preserved the garret in which the great inventor had worked, as well as a fine collection of relics of Boulton & Watt.

Personals

E. F. Troop is now chief engineer for the P. H. Glatfelter Co., Spring Grove, Pa.

R. J. S. Pigott, formerly industrial engineer for the Bridgeport Chamber of Commerce, is now with the Crosby Steam Gauge & Valve Co., Boston, Mass.

E. H. Aldworth, formerly assistant chief engineer with R. Martens & Co., Inc., New York City, is now chief engineer with Livermore, Rojas & Co., Inc., New York City.

Society Affairs

The Engineering Society of Buffalo will meet on Nov. 9 to discuss "The Einstein Theory."

The Engineering Council has compiled figures, showing that out of the 170 Public Service Commissioners throughout the United States, only 6, or 3½%, are members of engineering societies.

The Columbus (Ohio) Section, A. S. M. E., is to hear an address on Nov. 12 by Howard J. Webster, of the Uniflow Boiler Co., Philadelphia, Pa. Mr. Webster will speak on the desgn and construction of the uniflow boiler.

The American Association of Engineers is to sponsor a conference on employment and professional education at the Congress Hotel, Chicago, on Nov. 12. The conference will last throughout the day and will deal with the subject's different phases very thoroughly.

The New England Water Works Association will hold its November meeting at the Copley Square Hotel, Boston, on Nov. 10. Four papers will be presented by John S. Caldwell, Engineer New England Insurance Exchange; W. R. Brann, Superintendent Water Works, Hallowell, Me., and Charles W. Sherman, of Metcalf & Eddy, consulting engineers, Boston, Mass.; Frank A. McInnes, Division Engineer, Boston, Mass.; and J. W. Ledoux, Consulting Engineer, Philadelphia, Pa.

The Society of Naval Architects and Marine Engineers is to hold its Twenty-eighth General Meeting in the Engineering Societies Bldg., New York, N. Y., on Nov. 11 and 12. Professional sessions will begin at 10 a.m. each day, and a number of excellent papers are to be presented. Among these are "Surface Condensers," by Luther D. Lovekin, and "Recent Advance in Oil Burning," by Ernest H. Peabody. These two papers will be presented on the 12th.

The Engineering Society of Western Massachusetts will make an inspection trip at 2 p.m., Nov. 11, hrough the plant of the H. B. Smith Co., Westfield, Mass., manufacturer of cast-iron steam-heating boilers and radiators. After the trip dinner will be served at the Hotel Bismarck. Following the dinner the regular October meeting of the society will be called to order, and Professor Breckenridge, of Yale, will speak on "The Evolution of the Cast-Iron Heating Boiler as Related to the Problem of Power and Fuel"

The Society of Liquid Fuel Engineers was organized Oct. 21, at the Engineering Societies Building, New York City. Dr. W. N. Best, F. R. S. A., was selected as the president. Among the Vice-Presidents were Earnest H. Peabody and Jarvis C Buxton; the treasurer was Roscoe C. Bulger, and the secretary was Charles F. Reuter. The list of incorporators included, besides the officers, the following: Albert A. Cary, Dr. John H. Banks, John C. Wait, Gano Dunn, Hart H. Fleming, Walter S. Rockwell, William Schwanhausser, and Edgar J. Kates. The society plans to secure quarters in the Engineering Societies Building in New York, very shortly.

Business Items

Charles L. Pillsbury Co., Engineers, announce that after Nov. 1 their Minneapolis office address will be 1200 Second Avenue South.

The Conveyors Corporation of America, formerly the American Steel Conveyor Corporation, 110 West 40th St., New York, has placed Clarence C. Brinley in charge of a new branch of their business to handle eastern and Canadian affairs.

The S. Obermayer Co., manufacturer of foundry equipment, and Hott-Patch furnace cement, has opened an office and warehouse at Blanchard and Ferry Sts., Newark, N. J., for the purpose of taking care of their export business. This warehouse will carry a very complete line and will be in charge of Mr. Beckman, formerly of Chicago.

Trade Catalogs

The Ajax Metal Co., Philadelphia, Pa., have published a new catalog in two editions, one in English, and one in Spanish. This was made necesary by the company's grawing export trade. The two editions are identical in text and illustrations, and cover all Ajax products from babbitt metals to car basses and castings, and ingot metal.

The Worthington Pump and Machinery Corporation, New York City, has ready for distribution a new catalog of marine pumps and other auxiliary equipment. This catalog is exceptionally thorough and complete. Its 125 pages describe in detail a very extensive line of pumping machinery and other auxiliary apparatus for steam-operated vessels. Engines and equipment for oil and other motor-driven ships will be covered in a separate publication.

Valves, Fittings and Tools is the title of a new 400-page catalog issued by the Walworth Manufacturing Co., of Boston. This book, which is intended for circulation only in foreign countries in which the British standard thread is used, is probably the most complete catalog printed in foreign languages covering pipe fittings, valves and tools that has yet appeared. A special bulletin has been prepared for use in the United States. The book is printed in four languages—English, Spanish, Portuguese and French. The arrangement is such that these appear in the same sequence on each page so that a man who can read only one language will have no difficulty in getting just the information which he desires. The catalog is profusely illustrated with engravings.

New Construction

PROPOSED WORK

Mass., East Lee—Carl Wurtzbach, High St., Lee, is interested in a proposed electric power plant to be built on the Housatonic River, here. Owner's name withheld.

Conn., New Britain—The City plans to develop a waterworks project including a pumping plant. Over $3,000,000. Jos D. Williams, City Hall, Engr., Hazen, Whipple & Fuller, 30 East 42nd St., New York City, Consult. Engrs.

N. Y., Buffalo—Geo. B. Post, Archt., 101 Park Ave., New York City, will receive bids until Nov. 22 for a 17 story hotel and theater building here including a steam heating system, for the Hotel Statler Co., Washington St. About $5,500,000. Noted May 3.

N. Y, Ossining—Chas. S. Ratigan, Supt. of Prisons, will receive bids until Nov. 23 for a 1 and 2 story building, two wings, 40 x 40 ft. and 28 x 120 ft., including a steam heating system, for additional accommodations at Sing Sing Prison. About $400,000.

Md., Baltimore—The Church Home & Infirmary, Bway. and Fairmont Ave., has engaged architects to prepare plans for a 6 story addition to hospital. An addition to the steam heating system will be installed in same. About $600,000. Wyatt & Nolting, 1012 Keyser Bldg., Archts.

Md., Baltimore—The Horn Ice Cream Co., 446 Aisquith St., plans to build an ice and ice cream manufacturing plants, at Low and Aisquth Sts. About $300,000. Archt. not yet selected.

Va., Richmond—The Heisler Auto Repair Co., 309 North Laurel St., is in the market for a 3 hp. motor.

O., Cleveland—The Euclid Ave. Baptist Church, c/o Rev. W. W. Bustard, Euclid Ave. and East 18th St., plans to build a church including a steam heating system. About $300,000. Archt. not yet selected.

O., East Cleveland (Cleveland P. O)—The City, c/o A. Carran, City Hall, plans to build a light plant. About $90,000.

Ind., South Bend—The Tavern Hotel Co. is having plans prepared for a 10 story, 85 x 165 ft. hotel including a steam heating system. About $750,000. R. T. France, 155 North Clark St., Chicago, Archt.

Mich., Detroit—The Bd. Educ., 59 Bway Ave., received bids for an addition to the school on Abbott St., including a plenum steam heating system, mechanical ventilating device, etc., from A. W. Kutche, 623 Ford Bldg., $217,213; Bryant & Detwiler, 2336 Dime Bank Bldg., $232,680; M. A. Mahoney, 400 Penobscot Bldg., $233,606.

Ill., Chicago—Marshall & Fox, Archts., 721 North Michigan Ave., will soon award the contract for a 3 story, 296 x 310 ft. power plant to generate 200,000 kw., at 100th St. and Commercial Ave. for the Commonwealth Edison Co., 72 West Adams St. About $5,000,000. Sargent & Lundy, 72 West Adams St., Electrical Engrs. Noted Feb. 2.

Ill., Rock Island—The State Utilities Comn. has authorized the receivers of the Rock Island Southern Railway Co. to abandon its electric line and install steam and gasoline motor cars.

Wis., Janesville—Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., are preparing a report for furnishing additional water supply for the city.

Wis., Albany—W. G. Kirchoffer, Engr., 31 Vroman Block, Madison, will receive bids until Nov. 12 for one centrifugal pump, motor and controlling apparatus for waterworks plant here; pump to be of 160 gal. per minute capacity against a total head of 165 ft.

Wis., Kenosha—C. Mantkus, 216 Sheridan Rd., had preliminary plans prepared for a 2 story, 140 x 150 ft. theater and commercial building. About $400,000. C. Augustine, Archt. and Engr.

Wis., Port Wing—The Northern Wisconsin Hydro-Electric Power Co., promoted by T. N. Okerstrom, has been granted permission to build a hydro-electric plant and dam on the Iron River. J. C. Jacobson, 533 Metropolitan Bank Bldg., Minneapolis, Minn., Engr.

Wis., Prairie du Chien—The City has appointed Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., to prepare report for furnishing additional water supply and a new pumping station.

Wis., Racine—Alvord & Burdick, Engrs., 8 South Dearborn St., Chicago, Ill., have prepared report recommending abandonment of the present municipal water station and instead install new pumps and filtration plants. Total estimated cost about $2,000,000.

Wis., Racine—The New York Market Co., 2907 Washington Blvd., is receiving bids for a 2 story, 94 x 112 ft. sausage factory including electric motors, etc. Parker's Engineering Co., 431 South Dearborn St., Chicago, Ill., Engr.

Wis., Sheboygan—The City had preliminary plans prepared for a new pumphouse. About $25,000. C. N. Boley, City Hall, Engr.

Wis., Union Grove—The State Bd. of Control, M. J. Tappins, Secy., Madison, is having plans prepared for a power plant at the Southern Wisconsin Home for the Feeble Minded, here. John C. White, Madison, Engr.

Ia., Pocahontas—C. Gilchrist, Co. Aud., will receive bids until Nov. 12 for a 2 story, 80 x 125 ft. court house including a steam heating system. About $400,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg, Des Moines, Archts.

Minn., Aitkin—Aitkin County is having plans prepared for a court house including a steam heating system. About $400,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Archts.

Minn., Minneapolis—The State Bd. of Control, D. E. Mullen, Secy., Capitol, St. Paul, will soon award the contract for a 4 story administration building including a steam heating and ventilating system to connect with the present central system, on the State University campus, here. About $500,000. O. H. Johnson, 715 Capital Bank Bldg., St. Paul, Archt. Noted July 27.

Kan., Peabody—The City had plans prepared for a small pumphouse and 9 miles of main. About $180,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

Kan., Pittsburg—A. L. Lamar, 1029 East 8th St., will receive bids until Nov. 15 for a machine shop and factory including a steam heating system, etc. About $12,000.

Kan., Stockton—Rooks County will soon receive bids for a 3 story, 80 x 100 ft. court house including a steam heating system. About $250,000. Frank C. Squires, 630 Kansas Ave., Topeka, Archt.

Mo., St. Louis—John F. Queeny, Pres. Monsanto Chem. Wks., 2nd and Lafayette Sts., plans to remodel the Old Southern Hotel, Broadway and Walnut Sts., into a 6 story, 150 x 300 ft. office building. About $500,000. Archt. not yet selected.

Tex., Austin—The Home Ice & Cold Storage Co., 3d St., plans improvements to its plant including new buildings and machinery. About $200,000. A. M. Fitzpatrick, Pres. and Gen. Mgr.

Tex., Dallas—The Mack Mfg. Co., Houston, is having plans prepared for a factory, here, including machinery for the manufacture of rotary drilling outfits and oil field supplies. About $1,000,000.

Tex., Ft. Worth—Thos. Holiday, Longview, is having plans prepared for a modern electrically driven hardwood lumber mill at 800 North Houston St., here. About $250,000.

Tex., San Antonio—The Bd. of Directors of the Southern Ice & Cold Storage Co. has voted for the erection of the first unit of a 20,000-ton ice storage warehouse. About $250,000. Mark Postlewaite, Mgr.

Okla., Tulsa—The Bd. Educ. will soon award the contract for a 4 story high school. About $800,000. Geo. Winkler, 414 Palace Pl., Archt.

Cal., San Diego—The San Diego Consolidated Gas & Electric Co. has applied for permission to appropriate 10 cubic ft. of water per second from the Pauma Creek to develop 560 hp. Diversion works consist of main ditch and a 25 x 125 x 900 ft. dam. About $225,000.

Que., Montreal—The Montreal Water Bd. will soon receive bids for two 12,000,000 gal. pumps and one 6,000,000 gal. pump.

Que., Montreal—The Riordon Pulp & Paper Co., here, plans to develop 250,000 hp. at Three Rivers.

Ont., Tillsonburg—The Canadian Cereal Mills Co., Stratford, plans to build an electrically driven flour mill, here. About $500,000.

Alta., Edmonton—The San Francisco & McMillan Oil Refining Co., Ltd., plans to build a plant. Estimated cost of initial unit, $500,000.

Australia, Morwell—The Secretary, Electricity Comnrs., State of Victoria, 673 Bourke St., Melbourne, Australia, will receive bids until February 24, 1921, for a generating and transmission plant, here, to develop an initial capacity of 50,000 kw. and a maximum of 150,000 kw. Plans also include a 90-mile transmission line from here to Melbourne, consisting, in the first stage, of one line of towers with 2 three-phase circuits each, having a capacity of 25,000 kw. Installation equipment for Melbourne is listed as follows:

Specification No. 32—Three 25,000-kw. turbo-alternator sets complete with condensing plant, pumps and all necessary accessories. Generators to be wound for 11,000 volt, three-phase, 50-cycle, 1,500 r.p.m. As an alternative 12,500 kw. sets will be considered at 3,000 r.p.m. In the same specification one 600-kw., 400-volt, three-phase, 50-cycle, 3,000 r.p.m. turbo-alternator is called for.

Specification No. 33.—Transformers and switchgear for controlling the above generators and also two high-tension lines. The transformers are to be of the single-phase, water-cooled outdoor type, 9,260 kva., each stepping up the voltage from 11,000 to 132,000, connected delta-star neutral permanently earthed, all the switchgear to be of the outdoor type and the necessary control panels, conduits, control cable and galvanized steel work as called for in this specification.

Specification No. 34.—Seven hundred miles of 37/14 S. W. G. wire (area 0.182 sq.in.); or Specification No. 37.—Seven hundred miles of aluminum steel reinforced cable. (Alternative.)

Specification No. 35.—Eight hundred and fifty suspension and one hundred strain towers, normal span, 700 ft.; or Specification No. 38.—Five hundred and fifty suspension and seventy-five strain towers, normal span 1,056 ft. (Alternative.)

Specification No. 36.—Fifty thousand suspension units to be made up into strings of seven and eight, suitable for 132,000 volts (for copper cable line); or Specification No 39.—Forty-five thousand suspension units to be made up into strings of seven and eight (for aluminum cable.) (Alternative.)

Specification No. 40.—One hundred and twenty-five miles ½-in. double galvanized steel cable.

Specification No. 41.—Complete installation of terminal station in which is included: Two 15,000-kva. synchronous condensers; two banks of 30,000-kva. water cooled transformers, 120,000 to 22,000 volts connected delta-star neutral point earthed through a resistance; one 12,000-kw. frequency changer, 22,000 volts, 50 cycle 20,000 volts, 50 cycle two banks of 6,000 kva. water-cooled transformers, 22,000 volts to 6,600 volts. Necessary 120,000-volt to 22,000-volt, 6,600-volt outdoor type swtchgear also control panels, cables, conduits, control wiring and all steel work.

Specification No. 42.—Complete installation of three substations in which are included banks of 3,000-kva. and 6,000-kva. transformers outgoing and incoming overhead and underground feeders. All this equipment will be of the indoor type.

Specification No. 43.—Two thousand steel telephone poles approximately 35 ft. high, to carry two telephone lines and one 22,000-volt feeder line between Morwell and Melbourne.

Specification No. 44.—Complete installation of telephone apparatus at the power house, terminal station and along the route of the transmission line. At the power station and the terminal station there will be in each a C. B. board suitable for 30 lines, to be extended at a later date to 100 lines; also all necessary high-tension telephone apparatus suitable for a telephone line operating in the vciinity of the 132,000-volt transmission.

The total cost of this project is estimated at $15,000,000. A number of bid forms and specifications have been forwarded to the Commercial Intelligence Branch of the Department of Trade and Commerce, Ottawa, Ont. Copies of the specifications may also be seen at the offices of the Canadian Manufacturers' Association, 42 St. Sacrament, Montreal, and at Traders' Bank Building, Toronto.

CONTRACTS AWARDED

Mass., West Medford—The American Woolen Co., 245 State St., Boston, has awarded the contract for a woolen manufacturing plant including a steam heating system on Boston Ave., here, to the Turner Constr. Co, 178 Tremont St., Boston, at $250,000.

Mass., Willimansett—The Stevens-Duryea Co. has awarded the contract for a 1 story, 34 x 41 boiler house to P. J. Kennedy & Co., Inc. 464 Maple St., Holyoke, at $30,000.

Conn., New Britain—The Bd. Educ. has awarded the contract for a 2 story, 60 x 240 ft. school including a steam heating system on Tremont St. to the Eastern Engr. & Constr. Co., 886 Main St., Bridgeport, at $330,000. Noted Sept. 28.

O., Canton—The Hoover Suction Sweeper Co. has awarded the contract for a 1 story, 50 x 60 ft. addition to its boiler house to L. W. Kilgore, Builders' Exchange, at $25,000.

O., Canton—The City has awarded the contract for a 2 story, 60 x 80 ft. addition to the Lehman High School to R. H. Evans Co., Schaffer Block, at $497,885. Contract for heating and ventilating system will be sublet.

O., Canton—The Bd. Educ. has awarded the contracts for the installation of a steam heating system in the Belden Ave. and the Grace Ave. schools to the Witters Co., at $42,600 and $42,900, respectively. Noted Oct. 19 and 26.

Wis., Marshfield—The City has awarded the contract for boilers to the Erie City Iron Wks., Erie City, Pa., at $22,000.

Kan., Baxter Springs—The Iowa Mining Co., 4th and School Sts., has awarded the contract for removing mill from Joplin, Mo., to here, and remodeling same, to Ben Hoskins, as $20,000. Gas engines will be installed in same.

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